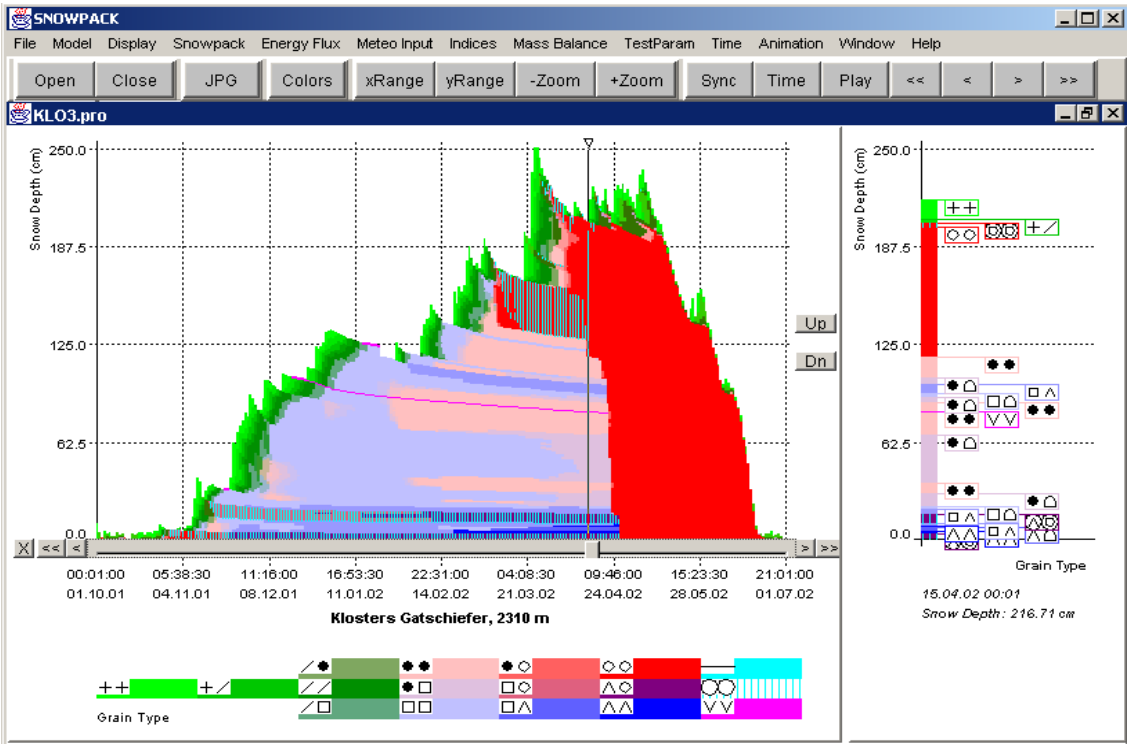
Snowpack_Win

USER MANUAL

Version 26 July 2006



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General User Agreement

1. SN_GUI and SNOWPACK are programs developed by the WSL Snow and Avalanche Research SLF. The functions of the programs are described in this manual.

2. The programs and the manual are protected by copyright. All rights are reserved to the SLF.

3. The SLF gives the user a non-exclusive, non-transferable, and temporally unlimited right of usage as specified in a separate contract on which basis SNOWPACK and SN_GUI are delivered.

4. Transfer or concession of the usufruct or exploitation rights to a third party is prohibited.

5. SNOWPACK is based on the current status of existing scientific research.

6. Any liability for damages occurring in relation to the use of SN_GUI or SNOWPACK, (in particular resulting damages, unrealised economies, lost profits etc. as well as commercialisation) is impossible.

7. SNOWPACK is constantly being developed. The development is particularly based on feed-back from the users. SLF is therefore interested on user experiences with SNOWPACK. Stimuli from the users are gladly received. The SNOWPACK user is usually informed about new versions and corrections etc.

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Appendix: A: Known Bugs

1. Introduction

1.1 General Remarks

The general acceptance and practical applicability of scientific software depends to a high degree upon the ease of operation and the availability of an excellent, up-to-date and accurate visualization of the numerical output. The Swiss Federal Institute for Snow and Avalanche Research (SLF) developed a graphical user interface for snowpack modelling (SN_GUI) designed to meet high quality standards. The software is specifically meant to accompany the Swiss snow cover model SNOWPACK but could also be used for other snow cover models. This manual is to provide to the user of SN_GUI all information he needs in order to work efficiently with SN_GUI.

The following conventions are followed throughout this manual:

- **File** and **directory** names are printed in bold.
- <Button names> used in dialog frames are listed within square brackets.
- *Names of menus* are listed in italics.

Since SN_GUI was tailor-made for the operation of the SLF model SNOWPACK, a brief review of this model is given in the next section (Section 2), followed by installation hints (Section 3) and a discussion of the principal features of the software (Section 4).

1.2 Technical Notes

SN_GUI is based upon the object-oriented and platform-independent programming language Java, meaning that the program execution in different operation system environments (Windows, LINUX, Solaris, etc.) is possible. The source code of the current version (around 700 KB in size), consists of 50 Java classes and more than 300 methods (= subroutines). It was compiled with the aid of the JBuilder software, using Swing libraries to create some special graphical effects.

1.3 Structure of SN_GUI

The user of SN_GUI is graphically guided through the entire process of creating snow cover simulations. This starts with the efficient production of input parameter files for SNOWPACK (see Section 4.2), followed by a variety of parameter settings (Section 4.3), and terminating with the model output visualization for an extended set of parameters (Section 4.4).

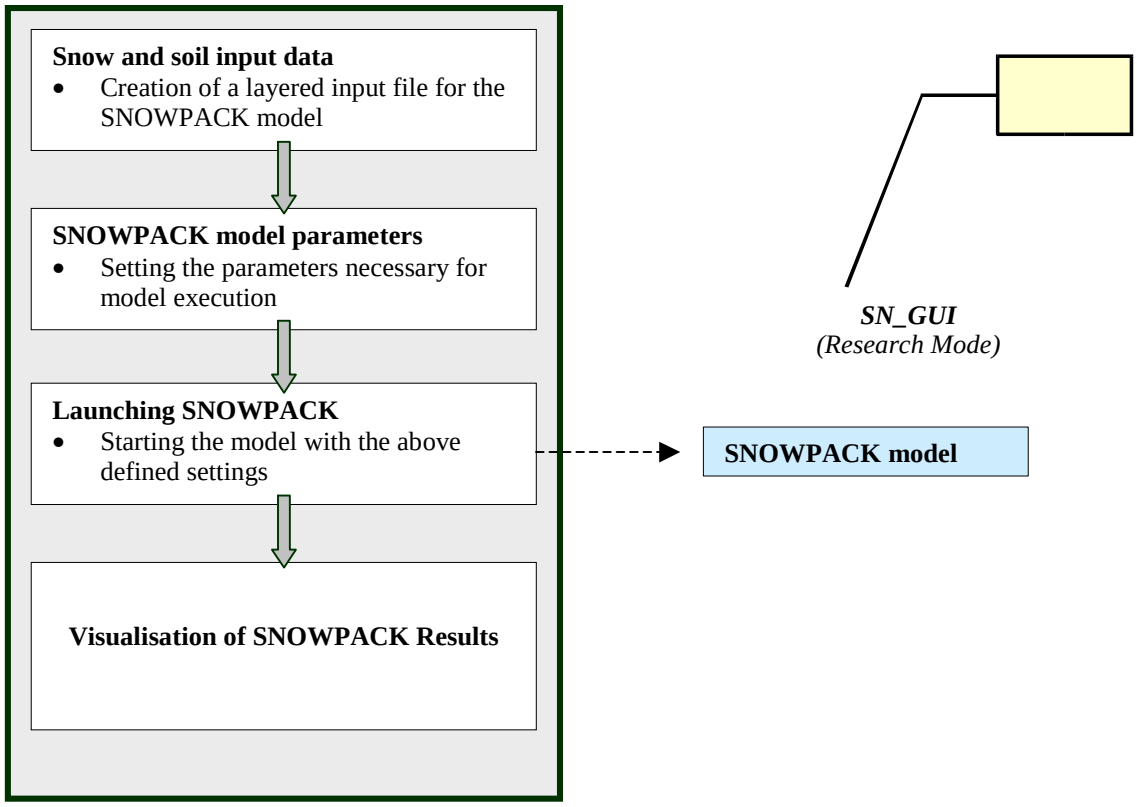

Snow and soil input data
Creation of a layered input file for the SNOWPACK model
SNOWPACK model parameters
Setting the parameters necessary for model execution
Launching SNOWPACK
Starting the model with the above defined settings
Visualisation of SNOWPACK Results
SN_GUI
(Research Mode)
SNOWPACK model

Figure 1: Review of the basic features of SN_GUI. The whole process of producing snowpack simulations can be managed graphically.

2. The SNOWPACK Model

2.1 Basics

The one-dimensional snow cover model SNOWPACK (Lehning et al., 1999; Bartelt and Lehning, 2002; Lehning et al., 2002a, b), programmed in C, was primarily developed for the support of avalanche warning in Switzerland. However, this physical model is also used for other applications such as permafrost investigations (Lütschg et al., 2003), the assessment of snow – vegetation interactions, climate research (Rasmus and Räisänen, 2003), mass- and energy balance calculations for arctic areas (Meirold-Mautner and Lehning, 2003) and calculations of chemical solute transport in snow (Waldner et al., 2003). See section 2.2 for more details.

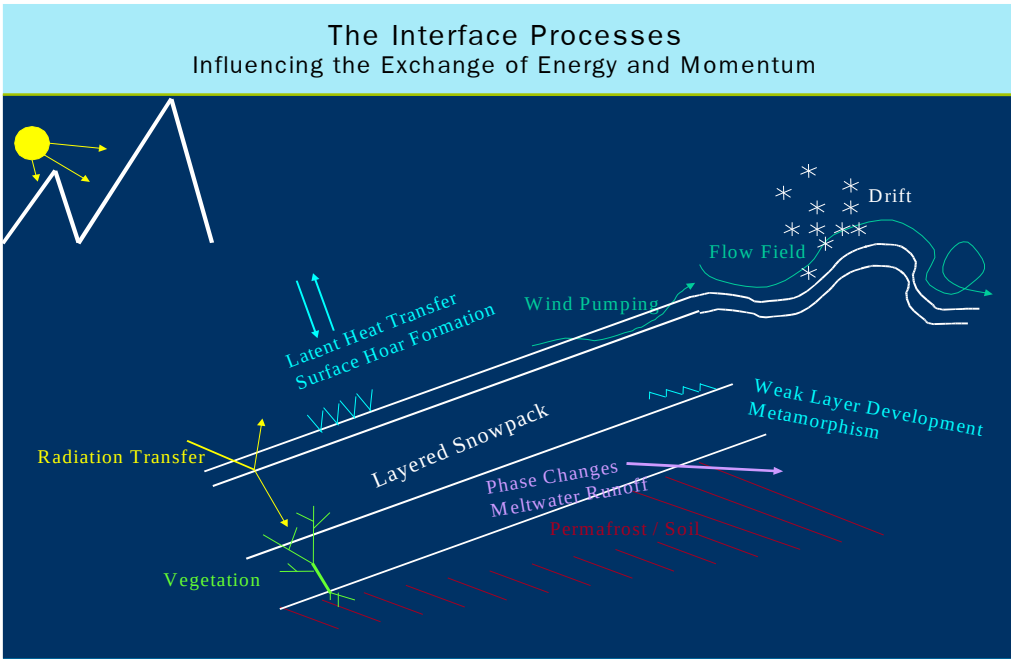


Figure 2: Principal physical processes included in the SNOWPACK model

A graphical review of the physical processes described by the SNOWPACK model is given in Figure 2. SNOWPACK is based on a Lagrangian finite element implementation and solves the instationary heat transfer and settlement equations. Phase changes and transport of water vapor and liquid water are included. Special attention is paid to the metamorphism of snow and its connection to mechanical properties such as thermal conductivity and viscosity. At present, SNOWPACK is the most advanced snow cover models worldwide in terms of microstructural detail. Therefore, first attempts are being made to estimate snow cover stability from SNOWPACK simulations (Lehning et al., 2003).

SNOWPACK runs operationally on a network of high Alpine automatic weather and snow measurement stations. Presently approximately 100 sites are in operation. These stations measure wind, air temperature, relative humidity, snow depth, surface temperature, ground (soil) temperature, reflected short wave radiation and three temperatures within the snowpack. The measurements are hourly transferred to the SLF and drive the model. SNOWPACK produces supplementary information regarding the state of the snowpack at the sites of the automatic stations. The model is connected to a relational data base which stores the measurements as well as the model results.

Validations of SNOWPACK suggest that the calculations are reliable in terms of the mass balance and the energy budget. The implemented snow metamorphism formulations yield reasonable grain types and are able to reproduce important processes such as the formation of depth or surface hoar.

In addition to the stand-alone applications, SNOWPACK is increasingly used in a distributed way. SNOWPACK has been coupled with atmospheric flow and snow drift modules as well as with spatial energy balance models. The coupled models are used to investigate snow deposition and snow cover development in steep terrain (Lehning and others, 2000) and to forecast ski run conditions for racing. However, the current version of SN_GUI does not include the visualization of distributed SNOWPACK calculations yet.

2.2 References

In the following some important papers related to the SNOWPACK model are listed. Additional information can be found on the web: www.slf.ch/lwr/prozessmodelle/aufgaben-en.html.

Bartelt, P.B. and M. Lehning. 2002. A physical SNOWPACK model for Avalanche Warning Services. Part I: Numerical Model. *Cold Reg. Sci. Technol,* **35**(3), 123-145.

Colbeck, S.C., E. Akitaya, R. Armstrong, H. Gubler, J. Lafeuille, K. Lied, D. McClung and E. Morris. 1990. The international classification of seasonal snow on the ground. Wallingford, Oxon, U.K., International Commission on Snow and Ice (ICSI), International Association of Scientific Hydrology. http://www.crrel.usace.army.mil/techpub/CRREL_Reports/reports/Seasonal_Snow.pdf

Lehning, M., P.B. Bartelt, R.L. Brown, C. Fierz and P. Satyawali. 2002a. A physical SNOWPACK model for the Swiss Avalanche Warning Services. Part II: Snow Microstructure. *Cold Reg. Sci. Technol*, **35**(3), 147-167.

Lehning, M., P.B. Bartelt, R.L. Brown, C. Fierz and P. Satyawali. 2002b. A physical SNOWPACK model for the Swiss Avalanche Warning Services. Part III: Meteorological Boundary Conditions, Thin Layer Formulation and Evaluation. *Cold Reg. Sci. Technol,* **35**(3), 169-184.

Lehning, M., C. Fierz and C. Lundy. 2001**.** An objective snow profile comparison method and its application to SNOWPACK. *Cold Reg. Sci. Technol.*, 33, 253-261.

Lehning, M., J. Doorschot, N. Raderschall and P.B. Bartelt. 2000. Combining snow drift and SNOWPACK models to estimate snow loading in avalanche slopes. In: *Snow Engineering, Hjorth-Hansen, Holand, Loset & Norem (eds.), Balkema*, 113-122.

Lehning, M., P. Bartelt, R.L. Brown, T. Russi, U. Stöckli and M. Zimmerli. 1999. Snowpack model calculations for avalanche warning based upon a new network of weather and snow stations. *Cold Reg. Sci. Technol.*, **30**(1-3), 145-157.

Lehning, M., C. Fierz, B. Brown, B. Jamieson,. 2003. Modelling Instability for the Snow Cover Model SNOWPACK. *Ann. of Glaciol.*, in press.

Lütschg, M., P.B. Bartelt, M. Lehning, V. Stoeckli and W. Haeberli. 2003. Numerical simulation of the interaction processes between snow cover and alpine permafrost. *Proceedings of the 8th International Conference on Permafrost, 21-25 July, 2003, Zurich, Switzerland*, in press.

Meirold-Mautner, I. and M. Lehning. 2003. Measurement and modeling of the solar shortwave fluxes in snow on Summit/Greenland. *J. of Glaciol*., in press.

Rasmus, S., J. Räisänen and M. Lehning. 2003. Estimating snow conditions in Finland in the late 21st century using the SNOWPACK–model with regional climate scenario data as input. *Ann. of Glaciol*., in press.

Spreitzhofer, G, Lehning, M. and C. Fierz. 2004. SN_GUI: A graphical user interface for snowpack modelling. *Environmental Modelling & Software*, submitted.

3. Installation

3.1 Installation Process

The SN_GUI software package can be installed in any directory along with the subdirectories **DATA, SETUP** and **snowpack**. The whole structure, including the files residing in the mentioned directories is described in the following section (3.2).

Currently no specific batch or script files exist to process the installation of SN_GUI. The user simply installs the SN_GUI package through copying a clone of the original file system onto a computer accessible by him. This file system may be available for a specific user at a number of different locations and media. This can for instance be a CD, or the SN_GUI package could be transferred to the user as a zipped email attachment.

When operating the SN_GUI on UNIX systems, one has always to make sure that through the copy process the original capitalization of the letters of the file names (see Figure 3) does not change.

The SN_GUI package can in theory be placed at any position of the user's directory system provided **DATA** and **SETUP** remain subdirectories of the directory where the SN_GUI package is installed.

3.2 File System Review

A review of the file system is provided in Figure 3.

SN_GUI.bat is used to start the the SN_GUI user interface. **SETUP.INI** contains the most essential setup parameters of SN_GUI.

With few exceptions, no manual changes of the files included in the SN_GUI package should be processed by the user. Advanced users might want to alter **SETUP.INI** and the default parameter settings in the files **PARDATA.INI** and **PARDATA203.INI** located in **SETUP** (see Section 4.4.2.4). The user interface for model settings of SNOWPACK (Section 4.3) is a comfortable tool to adjust the customized model settings, stored in the file **SETUP/CONSTANTS_User.INI**.

All files installed are necessary for the operation of SN_GUI, except for those residing in the **DATA** subdirectory. This directory was implemented for the convenience of the user and contains after the installation of SN_GUI some demo data which may be deleted. Input / Output files needed by the SNOWPACK model can be placed in (see Section 4.3, "Output File Path") and read from (see Section 4.4.2.1, menu *File/Open*) any directory.

If available, the code source is contained in an additional subdirectory **snowpack**. How to compile an executable from the source files contained in **snowpack/sources** will depend on the user platform.

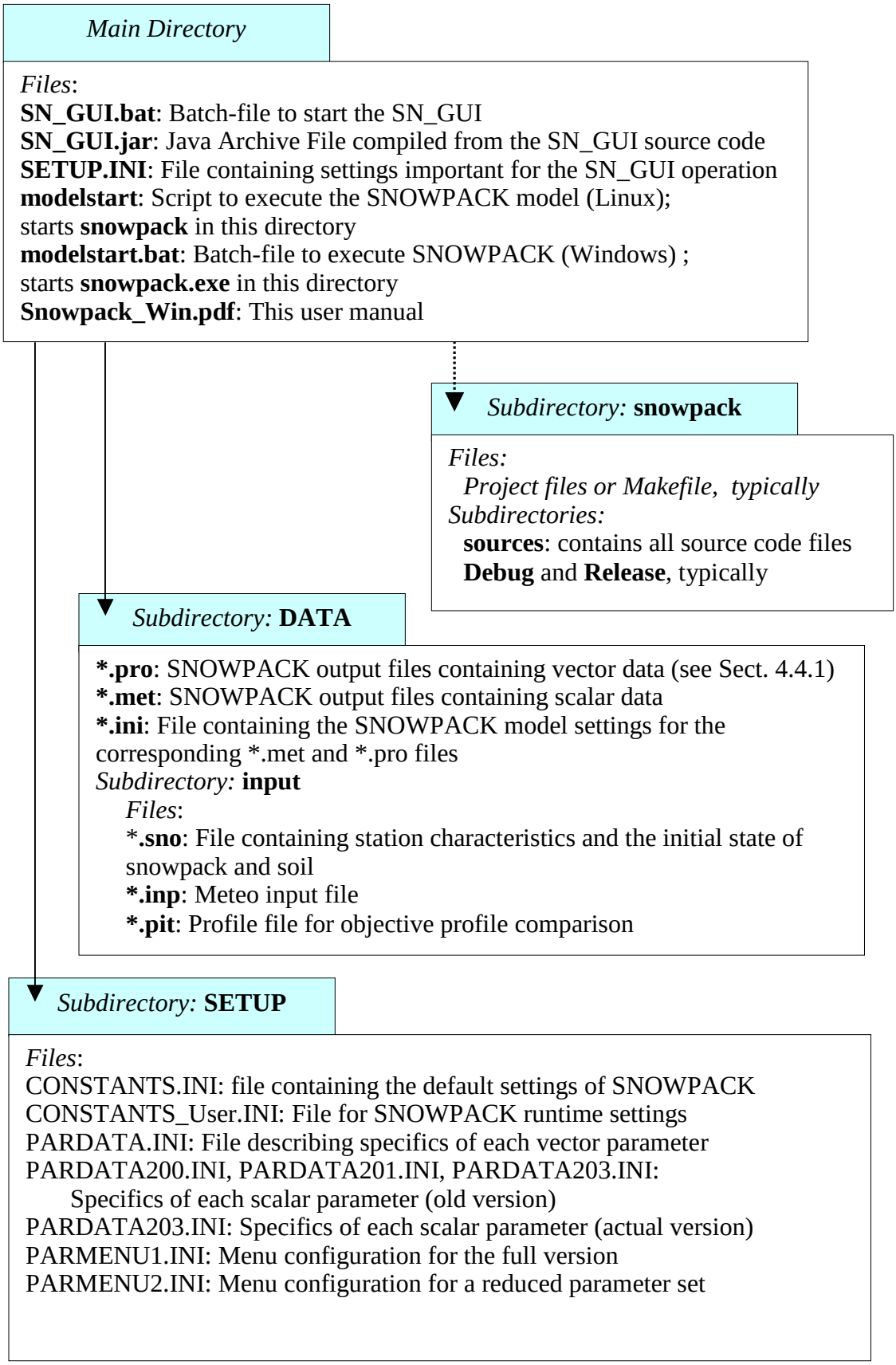

Main Directory
Files:
SN_GUI.bat: Batch-file to start the SN_GUI
SN_GUI.jar: Java Archive File compiled from the SN_GUI source code
SETUP.INI: File containing settings important for the SN_GUI operation
modelstart: Script to execute the SNOWPACK model (Linux);
starts snowpack in this directory
modelstart.bat: Batch-file to execute SNOWPACK (Windows) ;
starts snowpack.exe in this directory
Snowpack_Win.pdf: This user manual
Subdirectory: snowpack
Files:
Project files or Makefile, typically
Subdirectories:
sources: contains all source code files
Debug and Release, typically
Subdirectory: DATA
*.pro: SNOWPACK output files containing vector data (see Sect. 4.4.1)
*.met: SNOWPACK output files containing scalar data
*.ini: File containing the SNOWPACK model settings for the
corresponding *.met and *.pro files
Subdirectory: input
Files:
*.sno: File containing station characteristics and the initial state of
snowpack and soil
*.inp: Meteo input file
*.pit: Profile file for objective profile comparison
Subdirectory: SETUP
Files:
CONSTANTS.INI: file containing the default settings of SNOWPACK
CONSTANTS_User.INI: File for SNOWPACK runtime settings
PARDATA.INI: File describing specifics of each vector parameter
PARDATA200.INI, PARDATA201.INI, PARDATA203.INI:
Specifics of each scalar parameter (old version)
PARDATA203.INI: Specifics of each scalar parameter (actual version)
PARMENU1.INI: Menu configuration for the full version
PARMENU2.INI: Menu configuration for a reduced parameter set

Figure 3: Review of the SN_GUI file system

3.3 Meteorological Input File

The format for the meteorological input file is the following:

```
MTO <STN_5859Data> 2
M 01.08.1958 05:00 21396.20834   9.6  0.674 0.3 356.1   0.0   0.0  276.6   1   -0.1 0   0   1   1   1   1   1 0.6
M 01.08.1958 06:00 21396.25000   9.6  0.675 0.8 343.0  27.1   5.3  288.7   1   -0.1 0   0   1   1   1   1   1 1.6
END
```

Here the number of meteo steps stands at the end of the top line and input data are described in Table 3.3.1 below. Note that not required parameters should be set to 0.0 if not available. Note also that this format is defined in the function ml_qr_ReadMeteo() in Queries.c and the advanced user can adapt this function to better fit existing data formats.

Description	Units	Required	Comments
M		yes	Start of meteo step line
Date		yes	Format: DD.MM.YYYY HH:MI
Julian date		yes	Relative to 01.01.1900 00:00 (1)
Air temperature	Either K or °C	yes	
Relative air humidity	Either 1 or %	yes	
Wind velocity	m s^{-1}	yes	At snow station
Wind direction	degrees	no	At either snow or wind station (2)
Incoming SW radiation	W m^{-2}	yes	At least one of both parameters must be available!
Reflected SW radiation	W m^{-2}		
Incoming LW radiation or Cloudiness	W m^{-2} 1	no	If neither parameter is available, SNOWPACK will assume a clear sky air emissivity
Snow surface temperature	Either K or °C	(yes)	Required only if Dirichlet boundary conditions are chosen (see Section 4.3)
Bottom temperature	Either K or °C	(yes)	Required without soil and if Dirichlet boundary conditions are chosen for soil (see Section 4.3)
Precipitations per meteo step	kg m^{-2} (mm H_2O))	yes	At least one of both parameters must be available, but both column must be there! (3)
Snow depth	m		
Measured snow/soil temperatures	Either K or °C	no	None to five values according to settings in CONSTANTS_User.INI (see Section 4.3)
Wind velocity	m s^{-1}	no	At wind station

Table 3.3.1 Description of meteorological input data

Notes:

1 Julian date as obtained from standard Excel is off by +2 days as compared with the true value!
2 If wind data are available for the wind station (see last entry below), it is advisable to enter the wind direction at the latter station for blowing snow computation
3 If no snow depth data are available and 0.0 must be entered, it may be advisable to unset the "Blowing Snow" switch (see <Model Settings>, Part 2("MODEL"), Section 4.3.1)

3.4 Snow Profile Comparison

Modelled profiles may be compared to observed pit profiles based on the method proposed by Lehning et al. (2001). To activate the comparison, the PROF_EVAL switch must be set to 1 ("Profile Evaluation", see <Model Settings>, Part 3("OUTPUT"), Section 4.3.1). Then the location and name of the file containing the observed pit profiles may be set ("Profile Data File", see <Model Settings>, Part 3("OUTPUT"), Section 4.3.1), the extension being "**pit**". Results will be written to the *.**pev** file in the output directory.

3.4.1 File Format for Observed Snow Profiles

"Profile Data File" may contain any number of observed profiles (see International Classification for Seasonal Snow on the Ground by Colbeck et al., 1990).

Any number of comment lines starting with a semicolon (;) may appear on top of the file (but only there), followed by the two lines:

```
;
[ <any text> ]
```

Each profile then starts with a line labelled 0900, followed by the profile number, the profile date, the snow depth HS and the total snow water equivalent HSW:

```
0900,PrfNr,Date as DD.MM.YYYY HH:MI, HS in m, HSW in kg m-2
```

Each property of interest is then assigned an unique label (described below in 3.4.1.1) which will start any subsequent line of the corresponding profile as:

```
Label, # of items, comma-separated list of items starting from bottom
```

Note that no blank lines should appear in the file! Below is an example of such a file containing one profile:

```
;Example pit profile file
;
[ DATA Pit Profiles STN_5859 ]
0900,1,02.11.1958 09:00,0.510,119.5
0901,7,0.100,0.200,0.410,0.440,0.505,0.508,0.510
0902,7,1,1,1,1,1,1,1
0903,7,1,1,1,1,1,1,1
0904,7,4,3,4,4,3,4,1
0905,7,7,4,2,2,2,7,1
0906,7,-1,-1,-1,-1,-1,-1,-1
0907,7,0.50,0.25,0.50,0.50,0.25,0.25,1.00
0908,7,-1,-1,-1,-1,-1,-1,-1
0909,7,-1,-1,-1,-1,-1,-1,-1
0910,7,-1,-1,-1,-1,-1,-1,-1
0921,3,0.153,0.332,0.510
0922,3,43.1,39.6,36.8
0951,0
0952,0
0955,0
0956,0
0961,7,0.000,0.100,0.200,0.300,0.400,0.450,0.510
0962,7,273.15,272.75,272.15,270.85,268.15,267.15,269.65
```

Snow properties belong to either of three categories, namely stratigraphic (e.g. grain size) or bulk (e.g. layer water equivalent) properties or profiles (e.g. snow temperatures). The currently implemented properties are summarized below:

3.4.1.1 Stratigraphic Properties

Here the # of items is the number of stratigraphic layers. The first item on a list corresponds to the bottom layer.

0901: Vertical coordinates of layers; Given should be upper boundary of stratigraphic layer (m)

0902: Wetness W1 (code)

0903: Wetness W2 (code)

0904: Majority grain type F1 (code)

0905: Minority grain type F2 (code)

0906: Grain type F3 (code)

0907: Grain size D1 (mm)

0908: Grain size D2 (mm)

0909: Hand hardness K1(code)

0910: Hand hardness K2(code)

Notes:
- Example of codification: for wetness 1, set W1=1 and W2=1;
  for wetness 1-2, set W1=1 and W2=2.
- F1 and F2 are coded according to the Swiss Snow Type Classification (SSTC, see Table 3.4.1).
- D2 is presently not used but must be set to –1 if missing. Accordingly, set any other missing property to -1, e.g. W1=-1 and W2=-1.

SSTC	Symbol	IC
1	+	1
2	/	2
3	●	3
4	□	4
5	∧	5
6	∨	7
7	○	6
9	⍾	4c

Table 3.4.1 Swiss Snow Type Classification (SSTC) along with symbols and corresponding International Classification (IC, Colbeck et al., 1990)

3.4.1.2 Bulk Properties

Here the # of items is the number of layers over which bulk measurements are performed (usually smaller than, but at most the number of stratigraphic layers). The first item on a list corresponds to the bottom layer.

0921: Top of bulk layer (m)

0922: Snow water equivalent HW of the layer(kg m^{-2})

Note:
- If no measurements are available, labels 0921 and 0922 may be either omitted or the # of items set to 0.

3.4.1.3 Profile Measurements

Here the # of items is the number of measurements. The first item on a list corresponds to the measurement nearest to or on the ground.

0951: Height of the measurement (m)

0952: Snow density (kg m^{-3})

0955: Height of the measurement (m)

0956: Snow liquid water content (% by Vol)

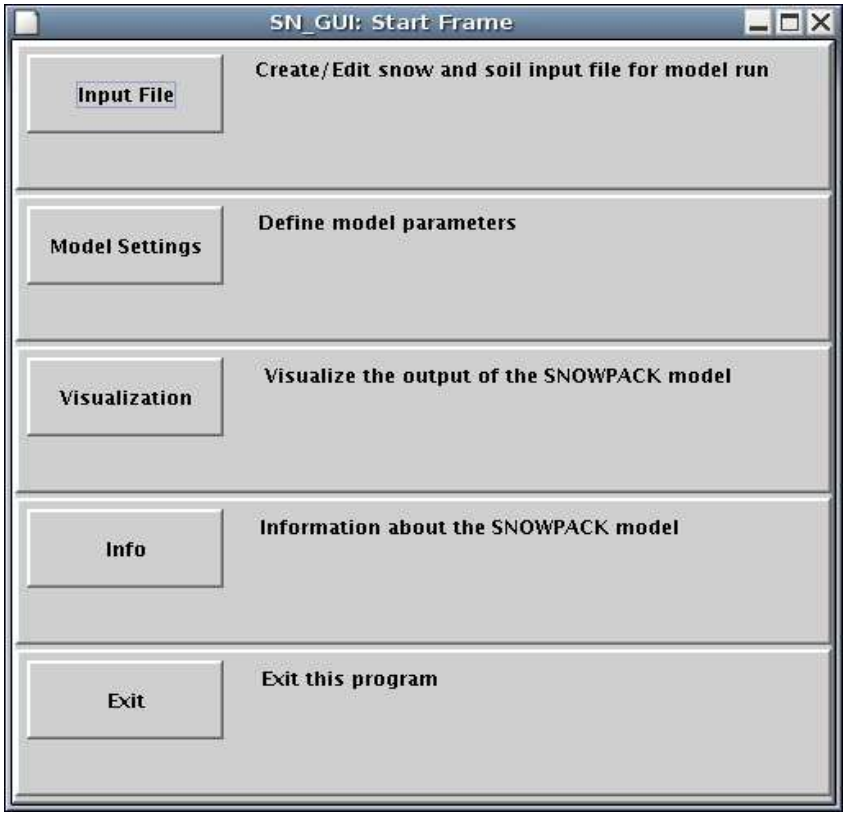
0961: Height of the measurement (m)

0962: Snow temperature (K)

Note:
- If no measurements are available, above labels may be either omitted pair wise or the # of items set to 0.
- Though surface temperature is presently not considered in the comparison, it has to be included in the list corresponding to labels 0961 and 0962

4. Operation of the SN_GUI

4.1 The Start Frame



SN_GUI provides graphical tools facilitating the operation of SNOWPACK. After starting the SN_GUI, the user is confronted with the following start frame:

Figure 4: Start frame of the SN_GUI, giving the user access to various subsystems.

Activating the buttons has the following effects:

<Input File> initiates a frame that allows the user-friendly construction of a file containing all needed information about station characteristics and the physical properties of soil and snowpack layers (Section 4.2). File creation may be based upon previously constructed files.

<Model Settings> allows the reading or adjustment of a file containing the parameters to run SNOWPACK (Section 4.3.1).

<Visualization> switches to the SNOWPACK visualization frame (Section 4.4).

<Info> will in the future provide information about the SNOWPACK model (not active yet).

<Exit> quits the SN_GUI.

4.2 Creation of a Snow and Soil Input File

In order to be able to operate the SNOWPACK model, the initial condition of the snowpack and the soil for the simulation site must be known. These data have to be resident in a specific file. The name of this file is one of the parameters set in the user interface for launching SNOWPACK (see Section 4.3, edit box labelled “Snow & Soil Data”). If such a file does not exist prior to a model run, it can be created through the “Snow and Soil Input File Creation” dialog frame. This user-interactive frame is accessible either by pressing the button <Input File> in the start frame (Section 4.1) or from the SNOWPACK visualization frame via *Model/Create Input File* (see Section 4.4.2.2). An example of it is displayed in Figure 5.

Prior to the popup of this frame, the user can by means of another dialog box decide from which source to access the default values. The two choices offered are:

- <Create New>: use hard-coded default values
- <Edit File>: default values can be read from a previously created snow and soil input file

The data input in the snow and soil input file user frame is processed in two steps:

§ Step 1 (Input of basic data):

First the path and name of the output file (absolute path or path relative to the SN_GUI directory) have to be stated (“File Name”), followed by the “Station Name” and the SNOWPACK simulation starting date (“Date of Profile”). After the input of the starting snow depth, the number of snow and soil layers must be given.

On the right-hand side, location information (latitude, longitude, altitude, slope angle, slope azimuth, soil albedo, bare soil roughness, canopy parameters) has to be listed. Some of these parameters appear in the split frames that visualize the results of the model runs (see Section 4.4.1).

Activating the <Continue>-button leads to a format check of the input data. If errors are detected, a message pops up and allows editing the data once again. If not, the present basic data are stored, and it can be proceeded to Step 2.

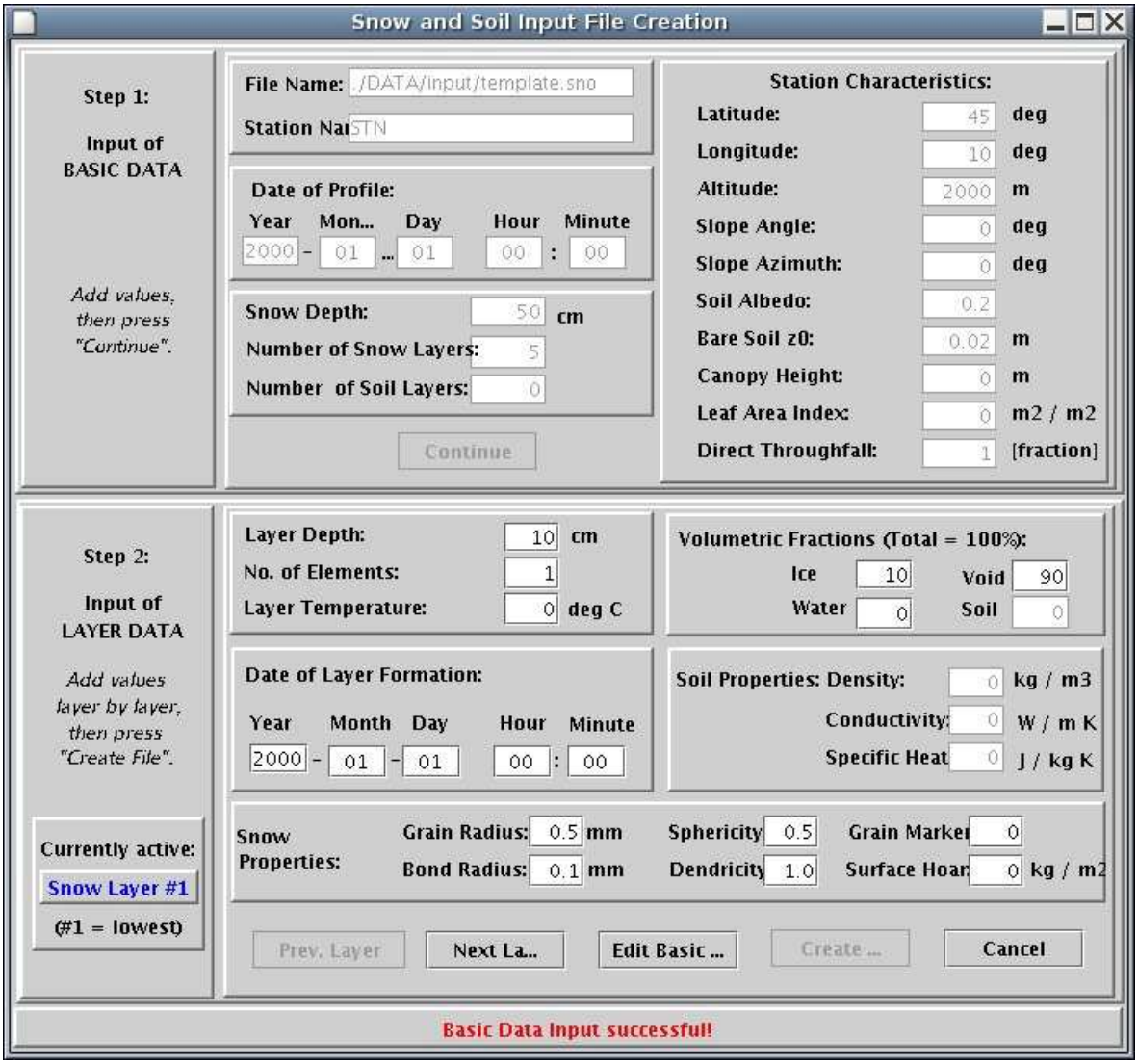

Snow and Soil Input File Creation
Step 1:
Input of BASIC DATA
Add values, then press "Continue".
File Name: ./DATA/input/template.sno
Station Na STN
Date of Profile:
Year Mon... Day Hour Minute
2000 - 01 - 01 00 : 00
Snow Depth: 50 cm
Number of Snow Layers: 5
Number of Soil Layers: 0
Continue
Station Characteristics:
Latitude: 45 deg
Longitude: 10 deg
Altitude: 2000 m
Slope Angle: 0 deg
Slope Azimuth: 0 deg
Soil Albedo: 0.2
Bare Soil z0: 0.02 m
Canopy Height: 0 m
Leaf Area Index: 0 m2 / m2
Direct Throughfall: 1 [fraction]
Step 2:
Input of LAYER DATA
Add values layer by layer, then press "Create File".
Currently active:
Snow Layer #1
(#1 = lowest)
Layer Depth: 10 cm
No. of Elements: 1
Layer Temperature: 0 deg C
Volumetric Fractions (Total = 100%):
Ice 10 Void 90
Water 0 Soil 0
Date of Layer Formation:
Year Month Day Hour Minute
2000 - 01 - 01 00 : 00
Soil Properties: Density: 0 kg / m3
Conductivity: 0 W / m K
Specific Heat 0 J / kg K
Snow Properties:
Grain Radius: 0.5 mm
Bond Radius: 0.1 mm
Sphericity 0.5
Dendricity 1.0
Grain Marker 0
Surface Hoar 0 kg / m2
Prev. Layer
Next La...
Edit Basic ...
Create ...
Cancel
Basic Data Input successful!

Figure 5: User interface for the creation of the snow and soil input file

§ Step 2 (Input of layer data):

As a second step, the physical characteristics of the input snow and soil layers are stated layer by layer, assigning each layer a specific depth, “Number of Numerical Finite Elements”, temperature and the volumetric fractions of ice, water, soil and air (void).

Furthermore, soil properties (density, conductivity, specific heat) and snow characteristics are stated. Among the latter are the date when the layer was deposited during snowfall event (“Date of Layer Formation”), grain radius, bond radius, sphericity, dendricity, “Grain Marker” and the amount of surface hoar.

Editing starts with soil layers (if the number of soil layers stated in Step 1 is not zero). Thereafter the snow layers are processed. The number of the currently edited snow or soil layer is visible in the lower left corner of the frame.

Once the input of data for one layer is finished, it can be moved on to the next layer, clicking the <Next Layer>-button. Clicking <Prev. Layer> allows to change to data of layers already edited before. The <Edit Basic Data> button provides the opportunity to edit once more the basic data (see Step 1).

Having defined snow and soil parameters for all the layers, clicking <Create File> finally creates the output file in a format readable by the SNOWPACK model (under the file name specified in step 1).

The activation of all these buttons (<Prev. Layer>, <Next Layer>, <Edit Basic Data>, <Create File>) first initiates a format and consistency check of the data currently residing in the edit boxes and may produce error messages, which can be removed by correcting the errors.

<Cancel> exits the dialog box without saving any of the currently displayed data.

4.3 Run SNOWPACK

4.3.1 Model settings

This is done through a user-interactive "model execution frame", accessible either by clicking the button <Model Settings> in the start frame (Section 4.1) or from the SNOWPACK visualization frame via *Model/ Model Settings* (see Section 4.4.2.2). An example of it is displayed in Figure 6. Before the proper frame is opened, a user dialog box appears, allowing to choose the file from which the default parameters for the frame's edit masks should be read. Two buttons can be clicked:

- <Default File>: The default parameters will be read from the file **SETUP/CONSTANTS.INI**.
- <User-def. File>: The parameters will be read from a file that can be chosen by the user.

The model setting frame serves the collection of essentials needed for the proper model execution. It consists of three parts:

Part 1 ("INPUT").

In the first part, beside naming the data files needed for the run, important information about the correct interpretation of the input data is handed over to the model. The following items have to be adjusted:

"Meteo Step Length": time resolution of meteo input data (in minutes)

"Measured Surface Temperatures Available": measured surface temperatures must be available if this item is selected

"Enforce Measured Snow Heights": measured snow depth is used to drive snowfall (if item is selected), otherwise the snow cover mass balance is determined from the precipitation data.

"Measured Incoming LW Radiation Available": measured incoming longwave radiation is available (if item is selected), otherwise SNOWPACK estimates a clear sky incoming longwave radiation from the air temperature and the relative humidity.

"Define SW Radiation":

1: measured shortwave radiation is reflected (if item is selected) or incoming (item not selected).
2 (or 12): means that reflected and incoming shortwave radiation is available and SNOWPACK will not use the statistical model of surface albedo.
10: both avail., but SNOWPACK will use only incoming;
11: both avail., but use only reflected");

"No. of Measured Snow/Soil Temp.": Gives information about how many measured temperature time series for fixed heights of the soil or snowpack are available. The depths of these series are given below (see Part 3 ("OUTPUT"), "Internal Temperature Depths").

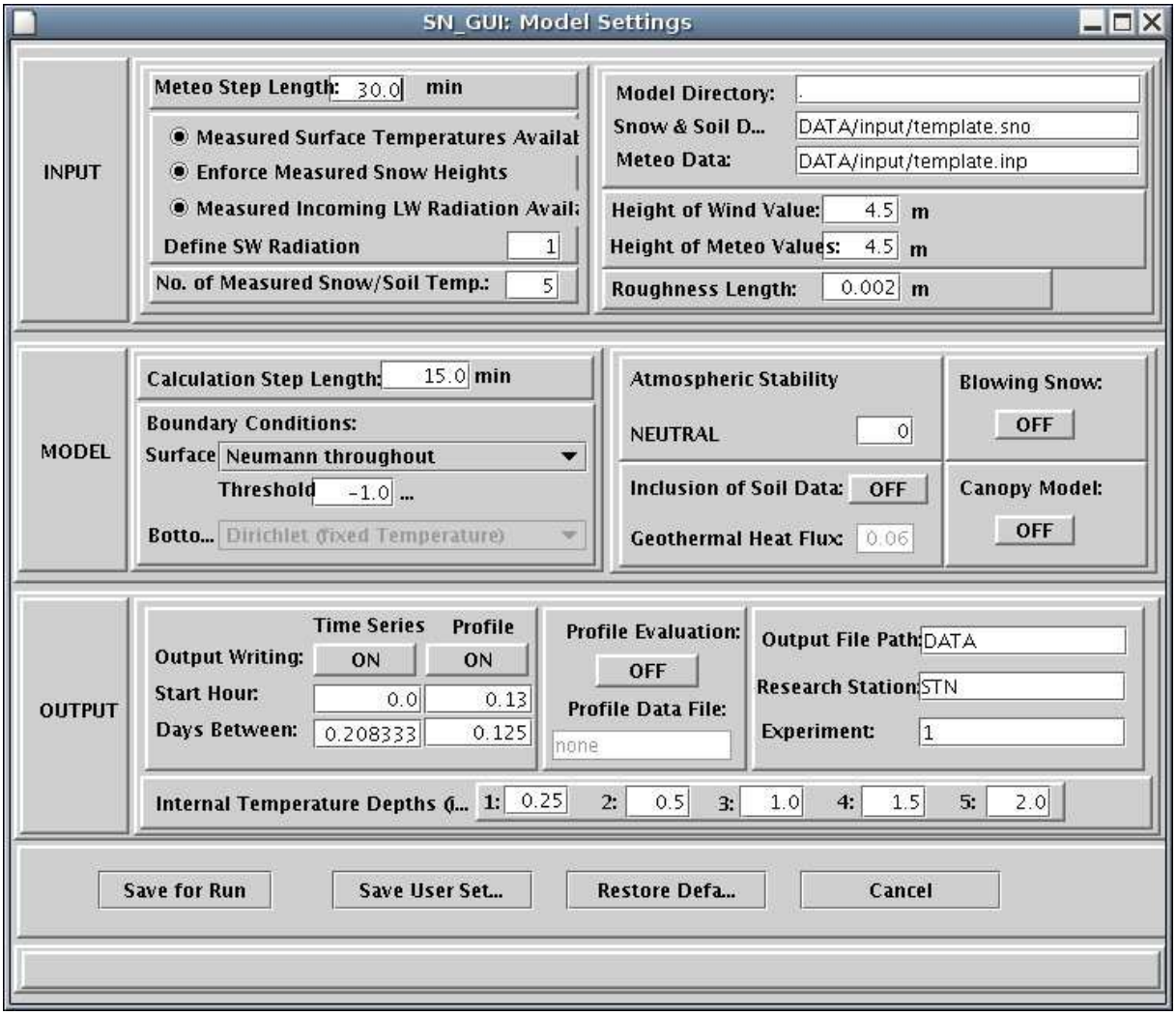


Figure 6: User interface for setting SNOWPACK parameters ("Model Setting")

"Model Directory": absolute path of the directory where the SNOWPACK executable file resides (usually SN_GUI), or path relative to the SN_GUI directory.

"Snow & Soil Data": File to initialize snow and soil data; usually found in DATA/input (relative to "Model Directory" or absolute path). This file may have been constructed through the user interface described in section 4.3.

"Meteo Data": Meteorological input data file; ; usually found in DATA/input (relative to "Model Directory" or absolute path).

"Height of Wind Values": height of the wind speed sensor above the ground (in m)

"Height of Meteo Values": height of meteorological sensors above the ground (in m)

"Roughness Length": roughness length over snow.

Part 2 ("MODEL").

Some important details about the mode of model execution can be laid down. Among these are the length of the internal computation time step ("Calculation Step Length") and the determination of the boundary conditions.

Concerning the upper boundary condition ("Surface"), there are two choices:

- Exclusive use of the Neumann Boundary Condition.
- Use of the Dirichlet Boundary Condition if the surface temperature is below zero.

"Threshold": Threshold for the measured surface temperature to automatically switch to Neumann Boundary Condition when melting is approached.

The choices for the bottom boundary condition ("Bottom") are:

- Neumann (fixed geothermal heat flux – only reasonable with a sufficient number of soil layers below the snow cover)
- Dirichlet (prescribed temperature)

"Atmospheric Stability" assumes the following stratification of the atmospheric boundary layer:
1: Assume neutral stratification (logarithmic profile), used preferentially with Dirichlet BC
0: Standard MO iteration with Paulson and Stearns & Weidner, used preferentially with Neumann BC
-1: Simplified Richardson number stability correction

"Blowing Snow": if set, SNOWPACK tests for blowing snow conditions (real erosion). Otherwise, virtual erosion will be performed only. The latter mode may be preferred if no snow depth data are available.

If soil data are to be included in the computations of SNOWPACK, "Inclusion of Soil Data" has to be set to ON. If it is OFF, no adjustment of "Geothermal Heat Flux" is possible and bottom boundary conditions cannot be selected.

"Canopy": to run SNOWPACK's canopy module.

Part 3 ("OUTPUT").

This portion allows to state details of the model output.

For both "Time Series" (scalar data, see Section 4.4.1) and "Profile" (vector data, also see 4.4.1), the construction of output files ("Output Writing") can be set to ON or OFF.

"Start Hour" gives the time (in hours) of the (first) data set to be written to the output file.

"Days Between" gives the time spacing (in days) for the data listed in the output files.

Further items that have to be stated are:

"Output File Path": Path to write the output files (absolute path or path relative to the "Model Directory", see above). One possibility is to use the **DATA** directory, included in the installed SN_GUI file/directory structure.

"Research Station": Name string for station data used. This string is used for the construction of the file name of the output files.

"Experiment": Name string specifying the run used for the construction of the name of the output file.

"Internal Temperature Depth": This item gives the distance (in meters) from either the ground surface or the snow surface for the output of temperature time series:
positive values: snow height measured from the ground
negative values without soil data: snow depth measured from the snow surface.
negative values with soil data: soil depth measured from the ground

Depth values for up to five modelled time series can be introduced. If measured temperature series are available, the depths of the sensors must match the values introduced here from left to right. Note that the number of measured temperatures do not need to match the number of modelled temperatures (see also "No. of Measured Snow/Soil Temp." in Part 1 "INPUT" as well as Section 3.3 "Meteorological Input File").

At the bottom of the frame, any of the following four buttons can be clicked:

<Save for Run>: Clicking this item, all stated input variables are checked for format and consistency errors. If any are found, a message pops up, and the errors can be corrected. If the input data are found to be free of errors, they are stored in the file SETUP/**CONSTANTS_User.INI** which will be used by modelstart (Linux) or modelstart_pc.bat (Windows).

<Save User Settings>: Clicking this item, all stated input variables are checked for format and consistency errors. If any are found, a message pops up, and the errors can be corrected. If the input data are found to be free of errors, they are stored in the file which the user can choose.

<Restore Defaults>: fills all the edit boxes with default values stored in the file **CONSTANTS.INI** (resides in the **SETUP** directory and can be changed manually by the user, if required).

<Cancel>: exits the frame without saving any data

4.3.2 Run SNOWPACK

Under Windows double click on **modelstart.bat**, under Linux start the script file **modelstart**. SNOWPACK is now started with the settings stored in the file SETUP/CONSTANTS_User.INI. See in section 4.3.1 “Model Settings” how to change these settings.

Notes:

- Command line: **snowpack(_pc.exe) SETUP\CONSTANTS_User.INI** [maxtime]
  where maxtime is given either as a julian or as dd.mm.yyyy HH:MM; allows to stop run prior to the end of the Meteorological Input File (see Section 3.3).
- Run will start at “Date of Profile” (see Section 4.2, Step 1) in any case; allows to start a run at a time posterior to the first entry in the Meteorological Input File (see Section 3.3).
- SNOWPACK can be run from any arbitrary location. However, paths to Input/Output files and parameter file must be properly set.

4.4 Visualization of the Output of SNOWPACK

The visualization module of the SN_GUI package was designed to make the results of the SNOWPACK calculations easily and comprehensively accessible to a wide range of users. The visualization frame has a menu bar at the top from which the individual menu items (various functions for data management plus graphical adjustment tools, see Section 4.4.2) can be chosen. Underneath is a tool bar, which allows accelerated access to some of the menu items (Section 4.4.3). At the bottom of the visualization frame is a status bar which is not fully functional yet.

The visualization is started by clicking the <Visualization>-button in the start frame (Section 4.1). The visualization frame can enclose one or more split frames (see Section 4.4.1).

4.4.1 Split Frames

The data calculated for a certain station and related to a specific parameter are displayed in form of split frames (see Figures 7, 8, 9, 10). The left side of such a frame always represents a time series and contains a bar that can be moved horizontally to specific dates. This is done by dragging a slider or by mouse-clicking interactive scroll buttons that are attached to the frame. The data referring to the currently marked date are visualized in the right part of the split frame. The vertical separation line between the left and the right part of split frames can be moved, dragging it with the mouse cursor (not recommended on a regular base, since this action may still produce errors).

Currently more than 50 parameters can be visualized by means of the SN_GUI (see Table 1).

A number of split frames can be displayed concurrently in the visualization frame and arranged in various ways (see Section 4.4.2.7).

The following buttons are attached to split frames:

<X>: Clicking on this removes all the buttons of the split frame, including the slider. The buttons can be reinserted via the menu item *Display /Slider + Buttons* (see Section 4.4.2.3).

<<: Moves the slider to the beginning of the displayed time range (see Section 4.4.2.5) or to the time range preceding the currently displayed one.

<: Moves the slider to the data record preceding the current one.

>: Moves the slider to the data record following the current one.

>>: Moves the slider to the end of the displayed time range or to the time range following the currently displayed one.

(The buttons <<, <, >, >> are also available on the speed bar, see Section 4.4.3).

<Up>: equivalent to *Display/Y-Interval Up* (see Section 4.4.2.3)

<Dn>: equivalent to *Display/Y-Interval Down* (see Section 4.4.2.3)

There are two main types of data and thus split frames:

- Scalar data (resident in files with the extension *.met). This type of parameter (e.g. the surface temperature of snow) is not related to individual layers of the snowpack. The left side of the split frame is a line graph, while the right-hand side gives the numerical value of the displayed parameter for the selected date. Depending on the parameter, and where useful, a number of line graphs can be displayed concurrently, for instance to compare modelled and measured data, indices or wind data from different altitudes (see Figure 7).
- Vector data (resident in files with the extension *.pro). This attribute refers to layer parameters such as the simulated vertical profile of the size of snow grains. For such data, the left part of the split frame describes the time evolution of the layered snowpack, and the right-hand graph gives a single-time vertical profile of the active parameter. The latter is usually a simple line-graph (see Figure 8), but for some parameters more sophisticated graphs are provided.

The right-hand side of Figure 9 for example gives a vertical profile of the grain form, based upon internationally recognized symbols. Melted and refrozen grain forms are marked by vertical hatching. Figure 10 provides information about the stability calculated by the SNOWPACK model. In the right-hand side of the split frame, the arrows mark the altitudes at which three stability parameters reach a minimum value. The numerical values (stability minimum, plus the altitude) are listed at the bottom.

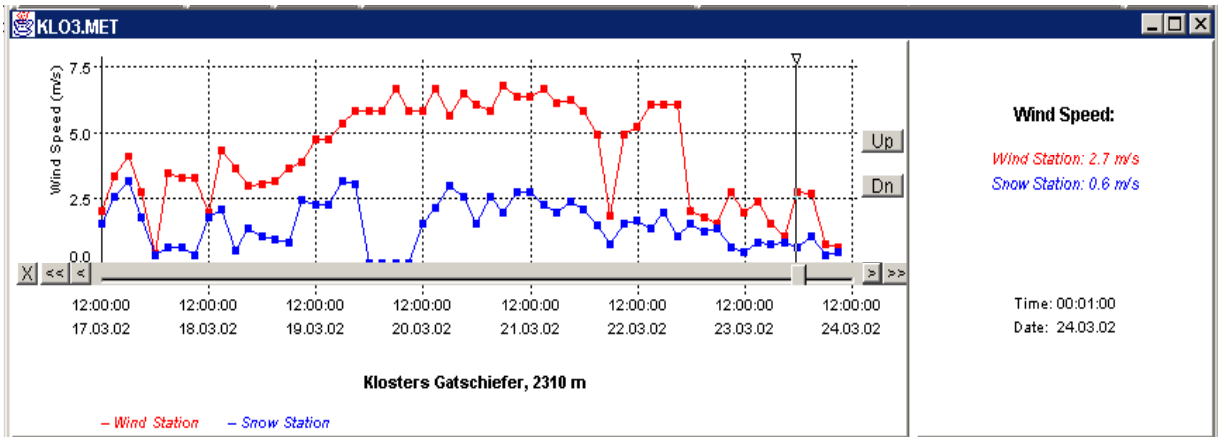


Figure 7: Split frame for the visualization of scalar data. Several parameters can be displayed concurrently within the same frame in different colours, in this example the wind data at two different altitudes, related to the station Klosters Gatschiefer (the upper curve gives the data for the higher sensor). The right-hand graph reveals the numerical values for the displayed parameters for the date marked by the slider position in the left part of the split frame.

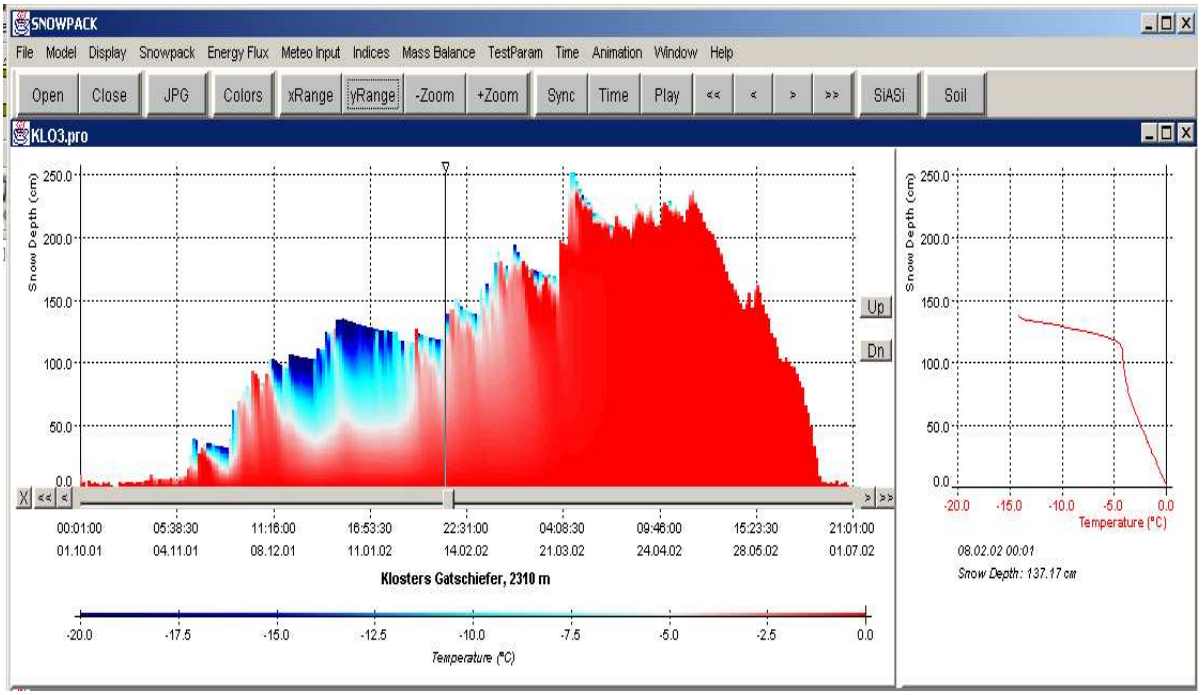

SNOWPACK
File Model Display Snowpack Energy Flux Meteo Input Indices Mass Balance TestParam Time Animation Window Help
Open Close JPG Colors xRange yRange -Zoom +Zoom Sync Time Play << < > >> SiASi Soil
KLO3.pro
Snow Depth (cm)
Up
Dn
Klosters Gatschiefer, 2310 m
Temperature (°C)
08.02.02 00:01
Snow Depth: 137.17 cm

Figure 8: Split frame for the visualization of vector data (displayed parameter: snow temperature)

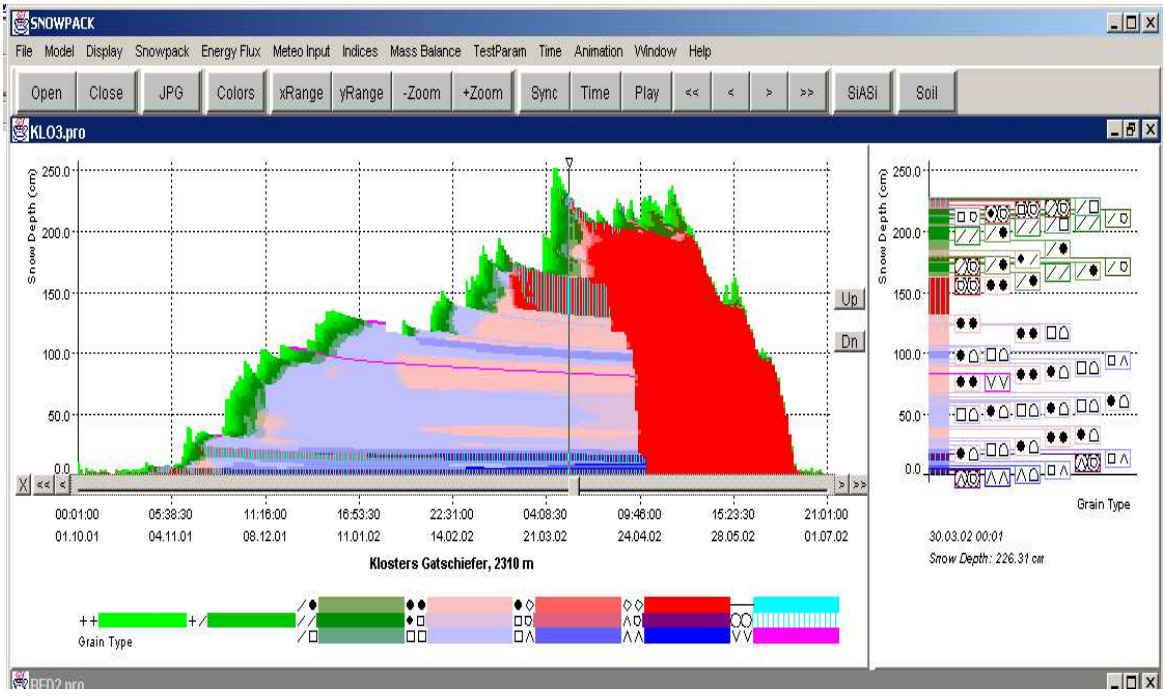

SNOWPACK
File Model Display Snowpack Energy Flux Meteo Input Indices Mass Balance TestParam Time Animation Window Help
Open Close JPG Colors xRange yRange -Zoom +Zoom Sync Time Play << < > >> SiASi Soil
KLO3.pro
Snow Depth (cm)
Up
Dn
Klosters Gatschiefer, 2310 m
Grain Type
30.03.02 00:01
Snow Depth: 226.31 cm

Figure 9: Split frame for the visualization of vector data (displayed parameter: grain type)

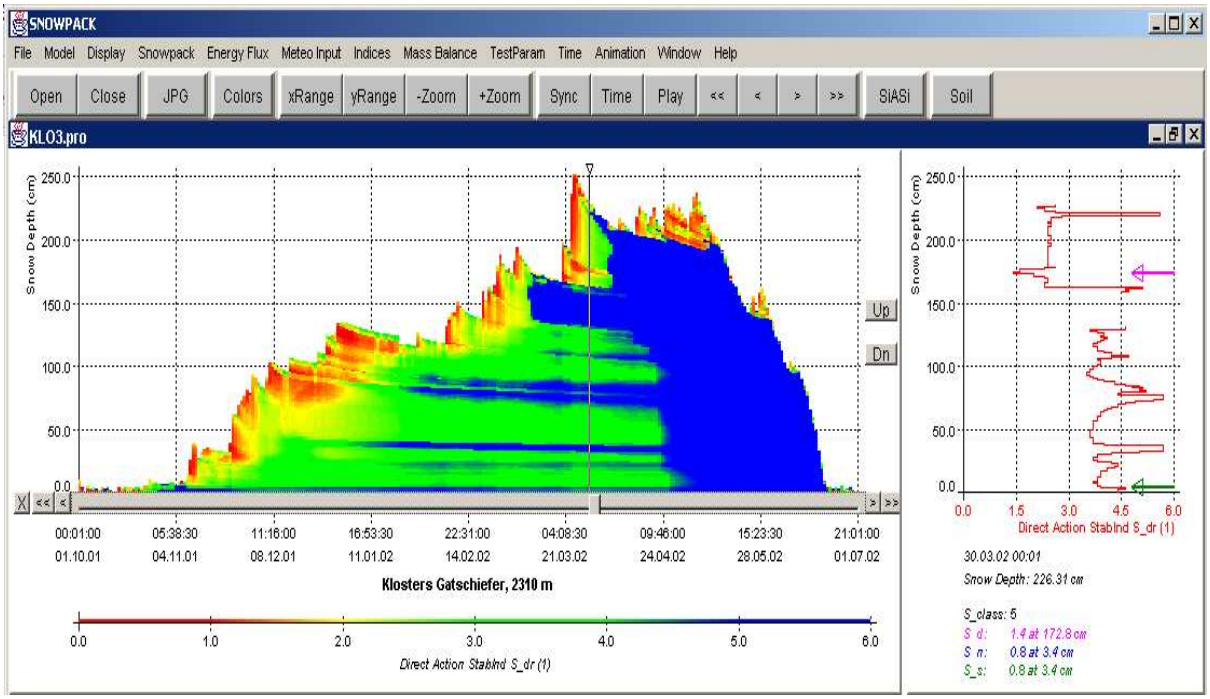
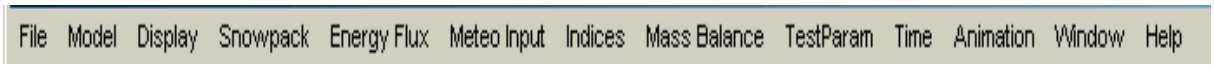

SNOWPACK
File Model Display Snowpack Energy Flux Meteo Input Indices Mass Balance TestParam Time Animation Window Help
Open Close JPG Colors xRange yRange -Zoom +Zoom Sync Time Play << < > >> SlASi Soil
KLO3.pro
Snow Depth (cm)
250.0
200.0
150.0
100.0
50.0
0.0
Up
Dn
00:01:00 05:38:30 11:16:00 16:53:30 22:31:00 04:08:30 09:46:00 15:23:30 21:01:00
01.10.01 04.11.01 08.12.01 11.01.02 14.02.02 21.03.02 24.04.02 28.05.02 01.07.02
Klosters Gatschiefer, 2310 m
0.0 1.0 2.0 3.0 4.0 5.0 6.0
Direct Action Stabind S_dr (1)
0.0 1.5 3.0 4.5 6.0
30.03.02 00:01
Snow Depth: 226.31 cm
S_class: 5
S_d: 1.4 at 172.8 cm
S_n: 0.8 at 3.4 cm
S_s: 0.8 at 3.4 cm

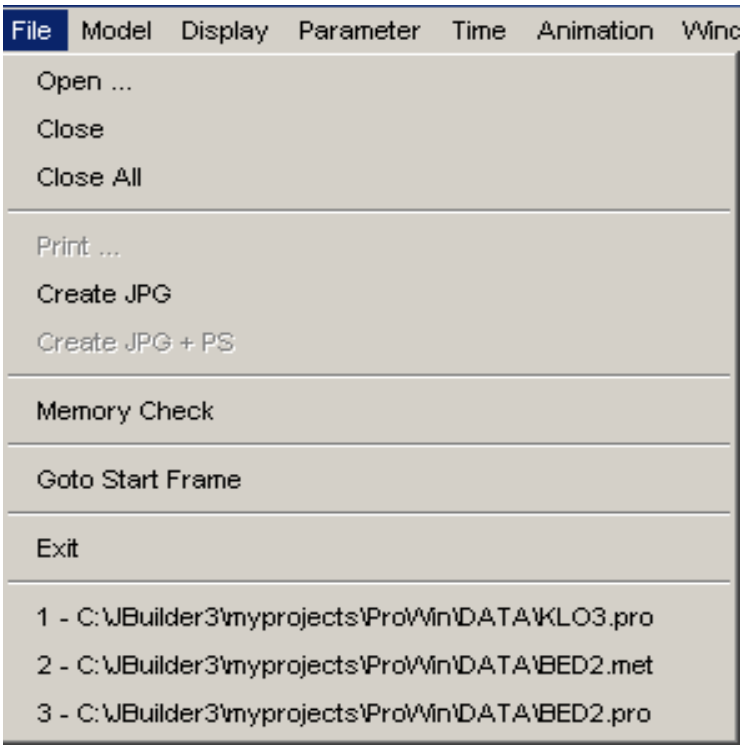
Figure 10: Split frame for the visualization of vector data (displayed parameter: direct action stability index)

4.4.2 The Menu Bar

In the following, the functionality of the menu items accessible by the menu bar is described in detail.



4.4.2.1 The *File* Menu



Menu *File/Open*:

Selecting *Open*, a file selection box pops up whose appearance depends on the operation system. Two types of data file (compare Section 4.4.1), both produced by SNOWPACK and residing in any accessible directory, can be chosen:

- *.pro-files: contain vector data
- *.met-files: related to scalar data

After selecting a file, its content is loaded into the memory, including a format check of the data. Detected errors may be visible in a background console window provided by the operation system. Once the data loading has finished successfully, a split frame related to the selected file appears, filling up the visualization frame and being set active. *.met and *.pro files contain valuable information about the station (Lat, Long etc as well as the depths of temperature sensors) .Now a wealth of display options is accessible by clicking the desired menu items (most of these are not selectable if no split frames are open). A default parameter is displayed which is snow temperature (for *.pro-files) or air temperature (for *.met-files). This parameter can be exchanged by another one at any time by choosing any items from the *Parameter* menu (see Section 4.4.2.4).

If the file is opened for the first time during a SN_GUI session, its name is appended to the list of menu items of the *File* menu (Section 4.4.2.1).

Other occasions where files are loaded, are after:

- clicking on recently opened files (menu *File/Recently Opened Filename*), or
- choosing a parameter (menu *Parameter*) related to a *.met-file if a *.pro-file is open (and vice versa)

Menu *File/Close*:

The currently active split frame is closed. If it was the last one open, a number of menu items will become inaccessible.

Menu *File/Close All:*

All open split frames are closed. A number of menu items will become inaccessible.

Menu *File/Print:*

Currently not usable.

Menu *File/Create JPG:*

This menu allows the creation of *.jpg images of the visualization frame which can be printed by a variety of programs. Clicking *Create JPG* leads to the emergence of a file selection box which is dependent on the used operation system. Here the name and the directory of the *.jpg-file to be created can be stated. The default name is SN_GUI.jpg. After selecting a name, all open split frames are arranged in a side-a-side-mode (see Section 4.4.2.7), and thereafter the *.jpg-file is created, including the whole visualization frame except for the menu bar (Section 4.4.2) and the speed bar (Section 4.4.3). A message window informs about the successful construction of the file.

Menu *File/Create JPG+PS:*

Currently not usable.

Menu *File/Memory Check:*

When a Java program such as the SN_GUI is executed, the Java Virtual Machine occupies a certain amount of memory ("total memory"). The "free memory" is this "total memory" minus the memory the program actually needs to run. The total memory is automatically adjusted from time to time, so unpredictable fluctuations of it (and also of the free memory) are not uncommon.

Clicking on *Memory Check*, both the total and the free memory of the Java Virtual Machine are listed in a message box.

Menu *File/Goto Start Frame*

Clicking this menu item results in the emergence of the start frame (see Section 4.1).

Menu *File/Exit:*

Termination of the SN_GUI.

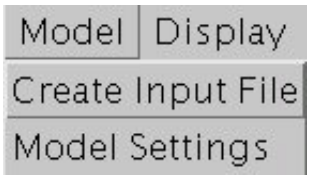
Menu *File/Recently Opened Filename:*

"*Recently Opened File*" stands for any path/file name.

The name of any file that is loaded for the first time during a SN_GUI session, is appended to the list of menu items of the *File* menu. It remains there, until the SN_GUI program is terminated.

Clicking on any of the appended filenames causes the construction of a new split frame related to that file.

4.4.2.2 The *Model* Menu



These functions are just accessible in the full version mode of SN_GUI (see 4.5).

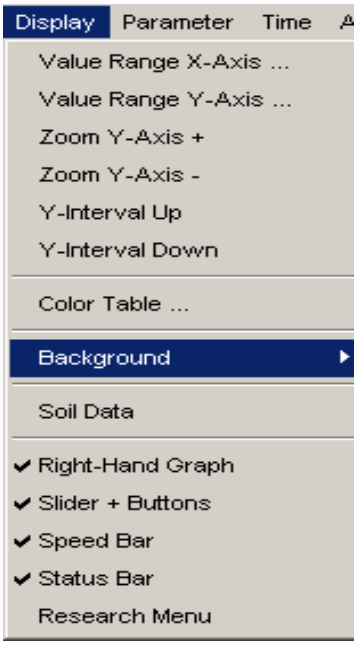
Menu *Model/Create Input File*:

Activating this item leads to the same result as clicking the button <Input File> in the start frame (Section 4.1). A frame is initiated that allows the user-friendly construction of a file which contains all needed information about station characteristics and the physical properties of soil and snowpack layers (Section 4.2).

Menu *Model/Model Settings*

This menu item allows the adjustment of a file containing the model parameters (Section 4.3.1). The functionality of this menu item is the same as that of the <Model Settings>-button in the start frame (Section 4.1).

4.4.2.3 The *Display* Menu



Menu *Display/Value Range X-Axis*:

This menu item is just available for split frames displaying vector data (*.pro-files; see Section 4.4.1). When clicked, a dialog window pops up (see Figure 11), allowing the scaling of the x-axis of the right-hand graph. The minimum ("Start Value") and maximum ("End Value") displayed parameter value can be reset. The number of vertical lines structuring the right-hand graph ("Partition Lines") can also be adjusted.

Having changed some of the values in the edit boxes, the <OK> button has to be pressed in order to transfer the changes to the active split frame or to all open split frames if the synchronization mode (Section 4.4.2.5) is on. Format errors will be communicated to the user and may be corrected. Clicking <Cancel> exits the dialog frame without implementing the proposed changes in the split frame.

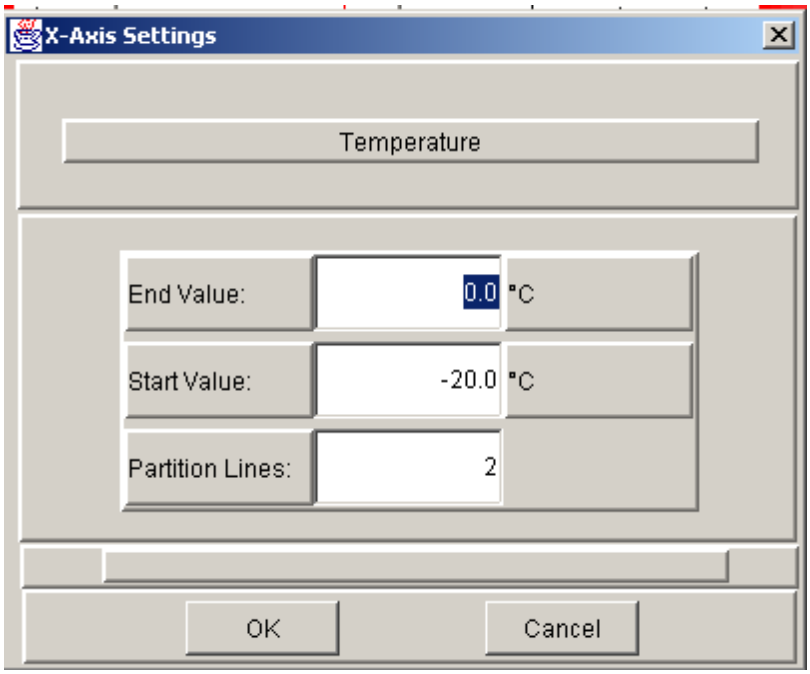


Figure 11: Dialog window to change the settings of the x-axis in the right part of a split frame

Menu *Display/Value Range Y-Axis*:

When clicked, a dialog frame very similar to that displayed in Figure 11 pops up, allowing the simultaneous scaling of the y-axis in the left-and and right-hand side of the split frame. The minimum ("Start Value") and maximum ("End Value") displayed parameter value can be reset. The number of horizontal "Partition Lines" can also be adjusted.

Having changed some of the values in the edit boxes, the <OK> button has to be pressed in order to transfer the changes to the split frame. Format errors will be communicated to the user and may be corrected. Clicking <Cancel> exits the dialog frame without implementing the proposed changes in the split frame.

Menu *Display/Zoom Y-Axis +*:

50%-zoom of the displayed y-axis range.

Menu *Display/Zoom Y-Axis -*:

200%-zoom of the displayed y-axis range.

Menu *Display/Y-Interval Up*:

Changes start and end value of the y-axis. While the y-axis range remains the same, the new start value is the old end value. Thus an "upward scrolling" through the data is possible by the multiple usage of this function. One application of this function is to scroll through the layers of the snowpack (with a constant layer depth).

Menu *Display/Y-Interval Down*:

Changes start and end value of the y-axis. While the y-axis range remains the same, the new end value is the old start value. Thus a "downward scrolling" through the data is possible by the multiple usage of this function, for instance from the upper layers of the snowpack to the lower ones (with a constant layer depth).

Menu *Display/Colour Table*:

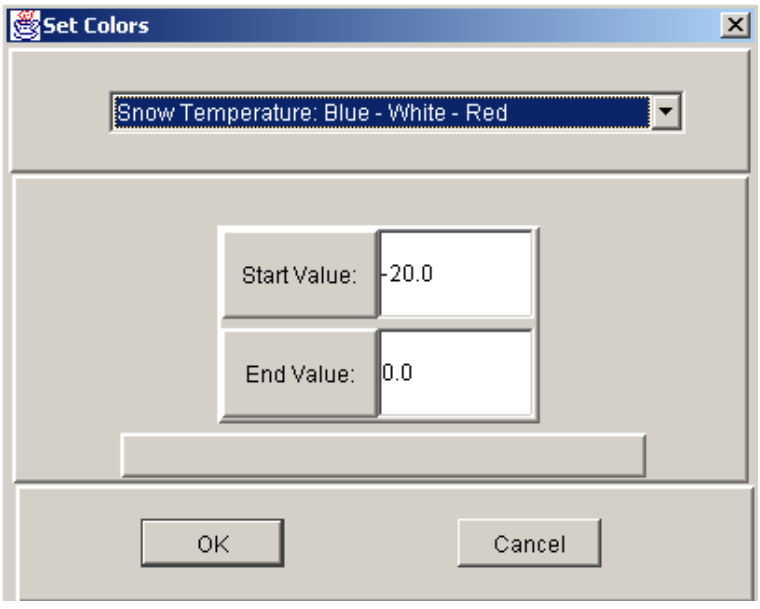


Figure 12: Colour dialog window

This menu item is available for split frames related to vector data only (*.pro-files; see Section 4.4.1), but not for the display of grain type. Clicking it, the colour dialog window appears which contains several edit-boxes related to the colour display. When a split frame emerges for the first time, it does so using default colour settings related to the displayed parameter (read from the file PARDATA.INI). The colour dialog window allows the adjustment of these default values. In the upper part of the dialog window it can be chosen among a variety of colour palettes, and in the center “Start Value” and “End Value” for the colour range are given. The numerical values in these text fields refer to the parameter and unit listed in the currently active frame.

Clicking <OK> adjusts the colours of the active split frame according to the changed settings. <Cancel> exits the frame without any actions.

Example: If the colour palette “Blue – Green – Yellow –Red” is chosen, “Start Value” is –10 and “End Value” is 0, and the active split frame is related to temperature, any snow layers with a temperature of –20, -15 and –10 degrees will be painted in blue, green tones will be used for –7 degrees, yellow ones for –3 degrees and red ones for zero degree.

Menu *Display/Background*:

A background colour can be chosen. Choices are *White*, *Light Gray* and *Black*.

Menu *Display/Soil Data*:

If this menu is checked, soil data (if calculated and available for a specific parameter) will be included in the display.

Menu *Display/Right-Hand Graph* :

If the menu is checked, the right-hand graph is displayed.

Menu *Display/Slider + Buttons*:

If the menu is checked, slider and control buttons (see Section 4.4.1) are displayed in the split frames.

Menu *Display/Speed Bar*:

If the menu is checked, the speed bar (see Section 4.4.3) is visible.

Menu *Display/Status Bar*:

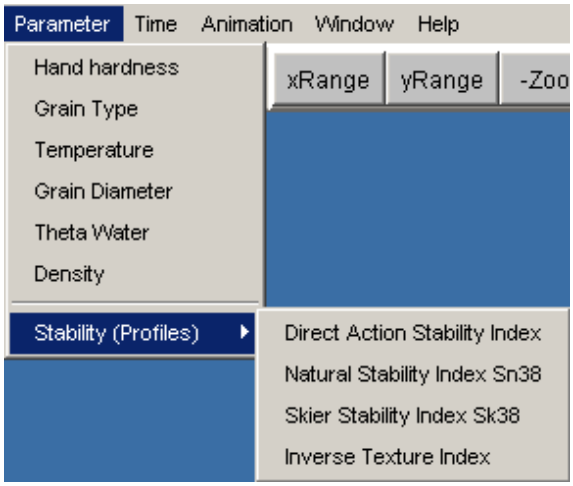
If the menu is checked, the status bar is visible. The status bar is situated at the bottom of the visualization frame and is not yet fully functional.

Menu *Display/Research Menu*:

This menu item allows to switch back and forth between the parameter choices of a reduced parameter set and the full version (see 4.5). If the checkmark is visible in front of *Research Menu*, the extended parameter set of the full version is on display.

4.4.2.4 The *Parameter* Menu

After the start of the SN_GUI an extended set of parameter menus and submenus is available, listed in the file **PARMENU1.INI**, residing in the **SETUP** directory. See Table 1 for a review of the parameters that can currently be visualized by the SN_GUI.



During runtime it can be switched back and forth between the parameter choices of the reduced and the full version, clicking the menu item *Display/Research Menu.*

A mouse-click on any of the available parameters has the consequence that either an adequate file and a new split frame are being opened, or that one of the open split frames (if possible the active one) is used for the visualization of the new parameter.

If it is wished to display a new parameter in any case in a separate split frame (thus two parameters related to the same data set can be displayed concurrently), the relevant file should be opened another time, clicking Menu *File/Open* or Menu *File/Recently Opened Filename*, followed by the choice of a display parameter from the parameter menu.

Advanced users can customize the files **PARDATA.INI** and /or **PARDATA203.INI**, focussing on the sections describing the properties of “Profile Parameters” (in **PARDATA.INI**) and “Time Series Parameters” (in **PARDATA203.INI**). Thus self-designed parameters can be displayed by means of the SN_GUI. Both files have a detailed syntax description in their header.

context	SN_GUI parameter
energy	snow temperature*, temperature gradient, conductivity, absorbed shortwave radiation
stresses and strains	overburden stress, viscosity
density and volumetric contents	Water vapor concentration, density*; volumetric content of ice, water*, air, void
microstructure	dendricity, sphericity, bond size, grain size*, grain type* (including surface hoar and refrozen layers), coordination number
energy flux	sensible and latent heat exchange, rain energy, soil heat fluxes, long wave radiation (incoming, outgoing, net), short wave radiation (incoming, outgoing, net, surface albedo, radiation on slopes, direct)
station data input	temperature (of air, at the snow surface, within the snowpack for fixed levels, in the ground), relative humidity, wind speed and direction, rain rate, snow depth
indices	hoar index, drift index, new snow (24 hours, 3-day sum), hand hardness*, inverse texture index*, vector stability indices (direct action*, skier stability*), scalar stability indices (stability index, depth stability index), classifications (profile type, stability)
mass balance	Snow water equivalent, erosion, runoff, sublimation, evaporation
parameter testing	dummy parameters** for any number of vector and 5 scalar data

Table 1: Review of the parameters that can currently be visualized by the SN_GUI. Where applicable, not only snow, but also soil layer data can be visualized.
(*) All listed parameters are available in the full version, but only the items marked by the star (*) can be accessed by the reduced parameter version.
(**) The properties of dummy parameters, such as menu names, default colour scales and value ranges, can be defined by the individual user. The output routines must also be adapted accordingly in Queries.c.

4.4.2.5 The *Time* Menu

The choice of any item of the first part of the *Time* menu changes the time range of the loaded data set displayed on the x-axis of the left side of the split frame, see Section 4.4.1. Generally, if possible, the new end time of the displayed time range will be set to the currently active time marked by the slider position.

Scrolling in time through the file is possible, for instance moving back week by week. For this, the buttons <<, <, >, >> (see Section 4.4.1, 4.4.3) have to be used.

Menu *Time/3 Days*, *7 Days*, *14 Days*, *30 Days* and *60 Days*: Clicking this item changes the displayed time range to 3, 7, 14, 30 or 60 days.

Menu *Time/Maximum Time*: The maximum time range available for the currently chosen parameter (depending on the input file) will be displayed in the left part of the split frame.

Menu *Time/Other Time*:

When clicking this menu item, a user window pops up (see Figure 13) which allows the display of any time ranges for which adequate data are available in the input file.

Start and end time (year, month, day, hour) of the data display period can be entered in the relevant edit boxes. <OK> implements the changes in the split frame, and clicking <Cancel> exits the time dialog window without further actions.

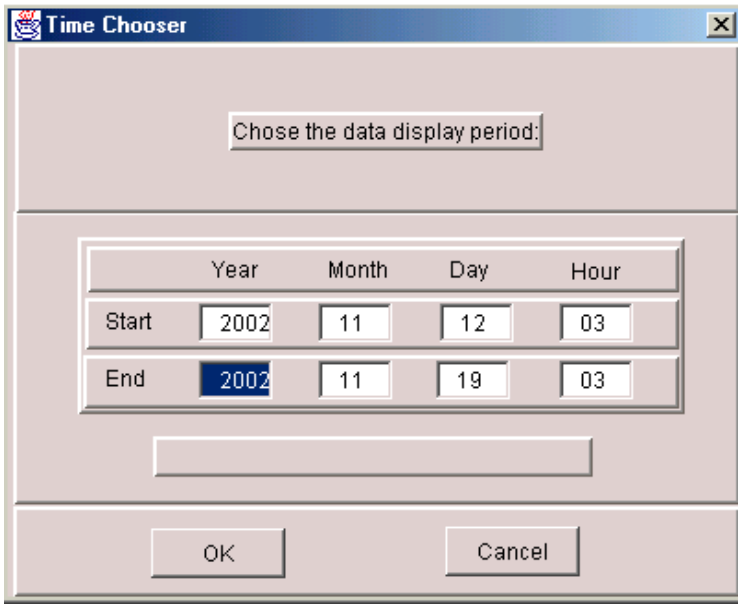


Figure 13: User window to state the start and end time of the time range to display

Menu *Time/Synchronization*:

Clicking this menu item allows the user to alternately activate or deactivate the synchronization mode. If the synchronization mode is on, a number of menu functions is simultaneously applied upon all open split frames, including:

- Zoom functions and scaling of the y-axis (see Section 4.4.2.3)
- Displayed time range
- Movement of the slider position through mouse dragging or through clicking specific buttons (<, <<, >, >>), see section 4.4.1

When activating the synchronization mode, the following actions are processed automatically:

1. First it is checked if all open split frames refer to the same data set. This is supposed to be the case if all the file names appearing in the title bars of the open split frames are equal (apart from the extension, which is either *.pro or *.met). If the file names are not equal, the synchronization mode cannot be established, and an error message appears. Advanced users can restrict the file name check to a selectable number of characters at the start of the file name, setting the parameter “SynLetters” in **SETUP.INI** to a value other than 0.
2. The time ranges displayed in the left part of all split frames are adjusted to display the maximum time range possible, and the slider button is moved to the last data record.
3. The open split frames are arranged in a side-a-side mode (see Section 4.4.2.7).

The synchronization mode is deactivated if the names of newly loaded files are not in agreement with those of open split frames.

When starting SN_GUI, the synchronization mode is by default deactivated.

4.4.2.6 The *Animation* Menu

The Animation menu allows the user to automatically time-lapse through the data set calculated by the SNOWPACK model.

Menu *Animation/Play*:

Clicking on *Play* initiates the animation using the currently active animation settings listed in the *Settings* dialog window (see Figure 14).

Menu *Animation/Settings*:

Clicking on this menu item leads to the display of the animation dialog window. Start and end time of the animation (Year, Month, Day, Hour) can be adjusted. As a default, the animation end time is set to the end of the currently displayed time range. The default start time is set in a way that around 30 time steps are included in the "movie".

The animation speed can be set on a scale between 1 (very slow) and 5 (very fast). Absolute values of the animation speed depend on specifics of the computer upon which the SN_GUI is operated.

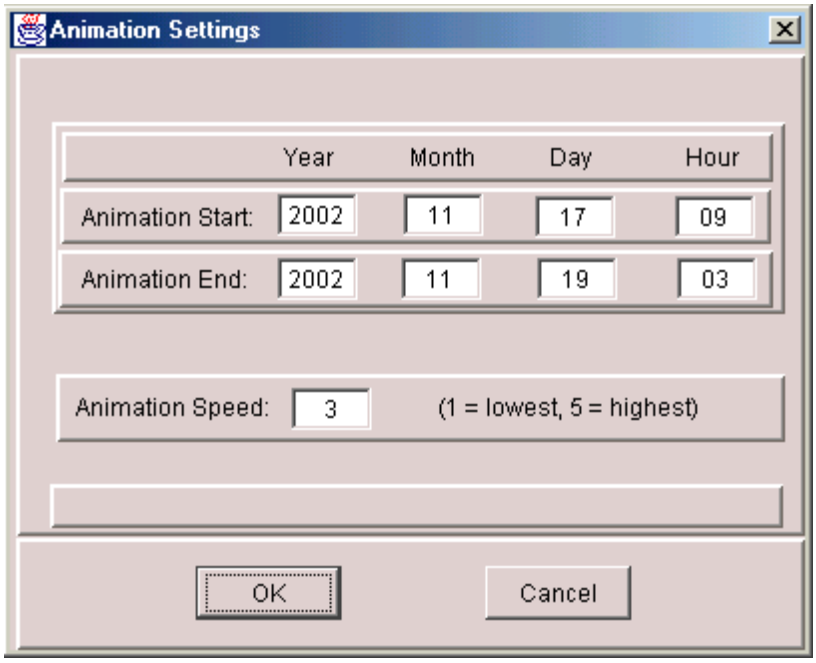
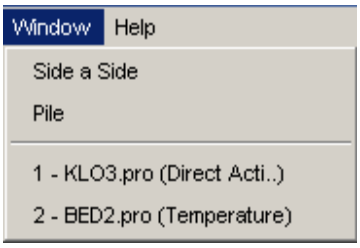


Figure 14: Animation dialog window

4.4.2.7 The *Window* Menu



A number of split frames can be displayed simultaneously within the boundaries of the main visualization frame of the SN_GUI, either in a side-a-side mode or in form of a pile of overlapping frames. This allows among other things an easy comparison of different model parameters at a specific location or the confrontation of the SNOWPACK output for different stations.

Menu *Window/Side a Side*:

New split frames created by using *File/Open* generally cover the whole area of the visualization frame, and any other previously opened frames remain in the background. Clicking *Side a Side* displays all currently open split frames concurrently on the screen. If more than three split frames are present, two columns are used for the display. An example of the side-a-side display mode is given in Figure 15.

The mode is also utilized whenever the synchronization mode is on (see menu *Time/Synchronization*).

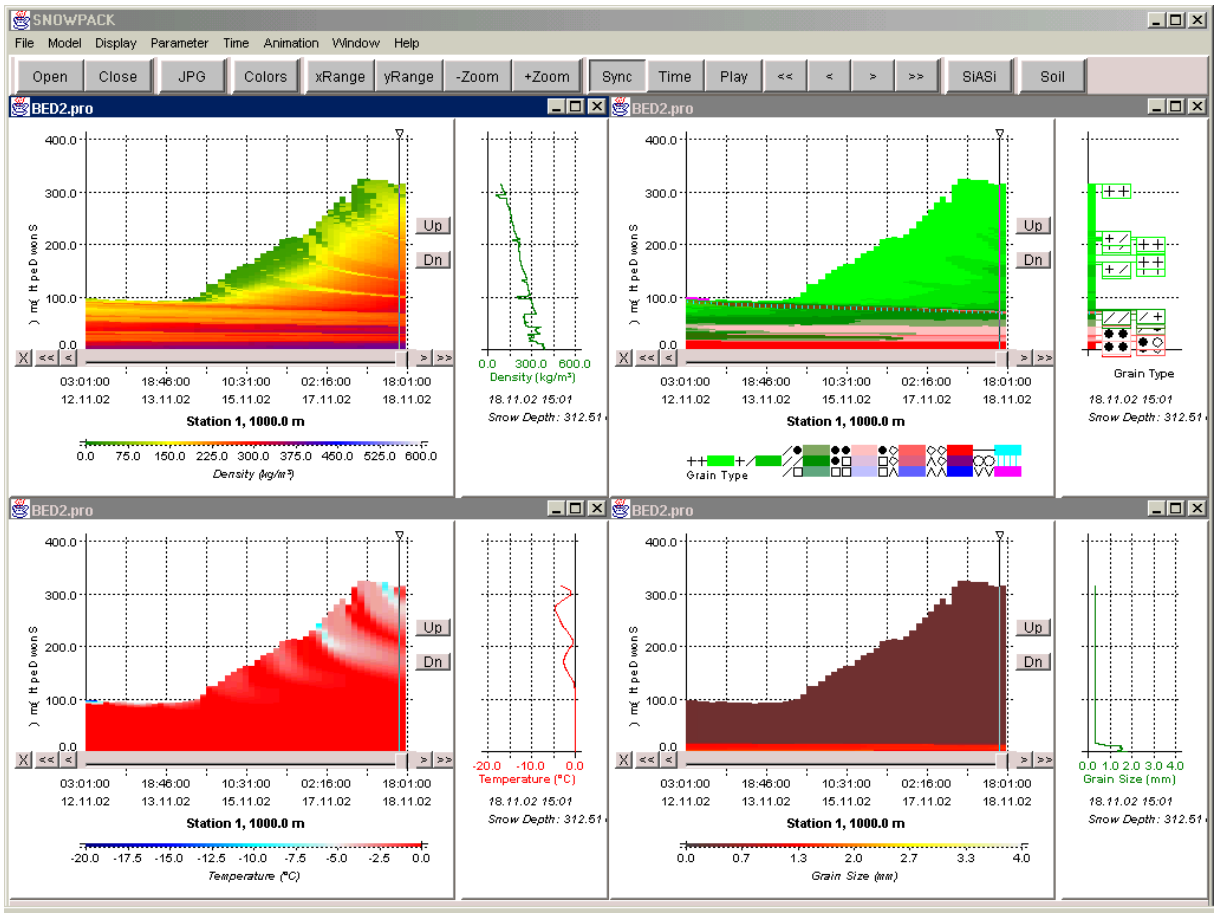

SNOWPACK
File Model Display Parameter Time Animation Window Help
Open Close JPG Colors xRange yRange -Zoom +Zoom Sync Time Play << < > >> SlASi Soil
BED2.pro
Station 1, 1000.0 m
Density (kg/m³)
Grain Type
Temperature (°C)
Grain Size (mm)
Snow Depth: 312.51

Figure 15 : Example of split frames arranged in the side-a-side mode

Menu *Window/Pile:*

Activating this menu item arranges all open split frames in the form of a staple (Figure 16). All frame title bars can be spotted, but the frames overlap each other and are, except for the topmost frame, not completely visible. The synchronization (see Section 4.4.2.5) is not usable if the split frames are arranged in this mode.

Menu *Window/Split Frame*:

At the end of the *Window* menu a list of menu items is appended referring to the currently open split frames. Clicking on any of these items is the suggested method to maximize frames.

"*Split Frame*" has for example the following form: '*1 - BED2.pro (Temperature)*'. The name of the file from which the active split frame is derived, is given (e.g. BED2.pro). The name of the active parameter (e.g. Temperature) is listed in brackets. Numbers in front of the file names indicate the chronology of the open split frames, with the most recently opened frame referring to number 1.

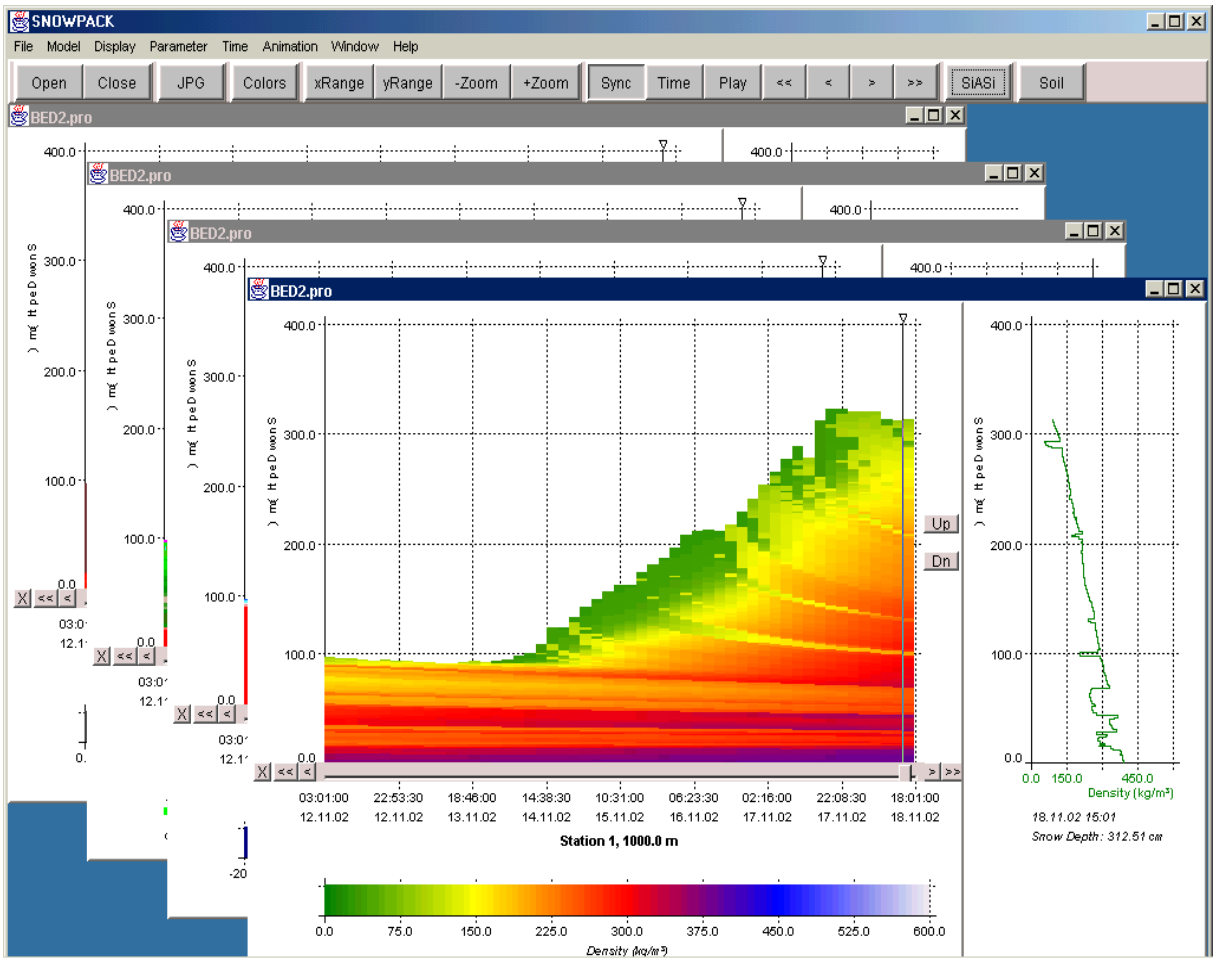
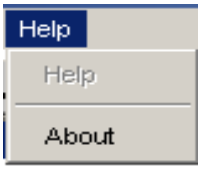


Figure 16 : Example of split frames, arranged in the pile mode

4.4.2.8 The *Help* Menu



Menu *Help/Help*:

Not implemented yet.

Menu *Help/About*:

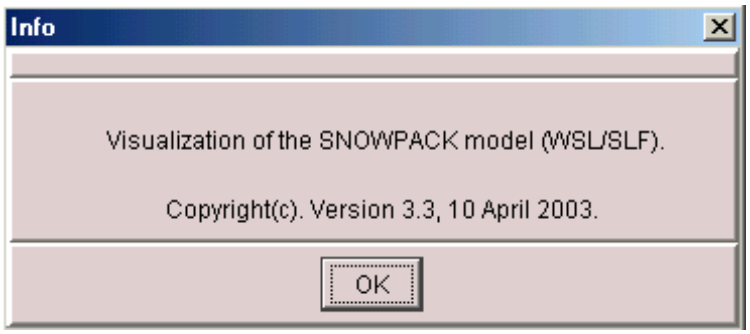


Figure 17: Help/About information window

Some information about the running version of SN_GUI is given (version number and date).

4.4.3 The Speed Bar

speed bar

Button of the Speed Bar	**Menu access**	**Section of this manual describing the function**
<Open>	*File/Open*	4.4.2.1
<Close>	*File/Close*	4.4.2.1
<JPG>	*File/Create JPG*	4.4.2.1
<Colours>	*Display/Colour Table*	4.4.2.3
<xRange>	*Display/Value Range X-Axis*	4.4.2.3
<yRange>	*Display/Value Range Y-Axis*	4.4.2.3
<-Zoom>	*Display/Zoom Y-Axis +*	4.4.2.3
<+Zoom>	*Display/Zoom Y-Axis -*	4.4.2.3

<Sync>	*Time/Synchronization*	4.4.2.5
<Time>	*Time/Other Time*	4.4.2.5
<Play>	*Animation/Play*	4.4.2.6
<SiASi>	*Window/Side a Side*	4.4.2.7
<Soil>	*Display/Soil Data*	4.4.2.3

Table 2: Review of connections between menu items and buttons of the speed bar

The speed bar is located below the menu bar. It can be switched on and off by clicking the menu *Display/Speed Bar*. The buttons containing the arrows (<, <<, >>, >) work the same way as their equivalents inside the split frames (see Section 4.4.1). The rest of the buttons has the same functionality as specific menu items accessible through the menu bar. For details see the Table 2.

4.5 Full Version versus Reduced Parameter Set

When starting the SN_GUI, some principal settings are read from the file SETUP.INI. The first lines of this file determine if the program is operated in the full or in the reduced mode. If the first is the case, the start frame (see Section 4.1) appears, otherwise the contents of the file **StartFile** (resident in the **SETUP** directory) is read. This may look similar to the following:

```
[StartFile]
; Name: file name to be used in reduced startup (4 windows constructed)
Name=./DATA/BED2.pro

;This terminates SN_GUI:
;Name=exit
```

The string after "Name=" gives the name of the file providing the data for the initial visualization frame. Four split frames referring to different parameters are constructed (similar to Figure 15), using synchronization and the side-a-side mode.

The full and the reduced version are related to different sets of parameters. Using *Display/Research Menu* (see Section 4.4.2.3), it can be switched back and forth between the two parameter choices.

Appendix A: Known Bugs

Below is an incomplete list of known program bugs of the SN_GUI. Beside these, some additional ones may occur, sometimes depending on the used JRE version (Java Runtime Environment).

1. Desktop management/Sizing of frames

A number of problems may occur when using the buttons for frame minimization and maximization in the upper right corner of the split frames. It is preferable to use *Window/Split Frame* for maximizing frames and *Window/Side a Side* for rearrangement once some frames were maximized. Possible errors that can occur when using minimization/maximization:

§ Minimization: after minimization no active frames remain, and applying many of the menu functions (such as zooming) does not show any visible effects

§ Maximization: The maximized split frames have the attached control objects (buttons and slider bar) at a wrong place. *Display/Slider + Buttons* can be used to remove these objects.

§ After maximizing split frames using *Window/Split Frame* and returning to the side-a-side mode clicking *Window/Side a Side*, any inactive frames clicked will maximize when clicked. Again, control objects may emerge at the wrong place.

§ Closing all windows: Problems occur when using *File/Close All* after maximizing any of the open split frames.

§ Split frame divider: When dragging the vertical line separating the left from the right part of split frames, the size of the slider bar underneath the x-axis of the left graph remains the same as before.

§ Start screen: In some cases the start screen was observed to “freeze” on the minimization of the visualization or of other frames.

2. Synchronization

§ Split frame divider: Synchronization problems occur when dragging the vertical line separating the left from the right part of split frames.

§ Data gaps: If a number of split frames are displayed simultaneously in the synchronization mode, and the individual frames contain data gaps at differing times, a movement over the gaps using either the slider or the key buttons (see Section 4.4.1) may result in synchronization errors.

3. Slider movement/Marker

In the left part of the split frame, a vertical line (“marker”) is connected to the slider button (can be dragged by the user, attached to the slider bar underneath the x-axis). This marks the date for which data details are displayed in the right part of the split frame. The following errors may emerge in this context:

§ Marker: Repainting of the split frame is automatically done after processing many of the menu options or clicking on the title bar of the frame. If after repainting the slider is moved through mouse-dragging, the original marker line remains on the screen (although the new one is drawn correctly). It can only be removed by processing another operation related to repainting.

§ Data gaps: If data gaps exist and the marker is moved over these from left to right, the data record immediately after the gap (to the right of it) is sometimes skipped, depending on parameters such as the number of missing records (odd or even).

4. Data loading

§ File choser box: If *File/Open* is clicked when open split frames exist, during the presence of the file choser box the expressions “ParameterError” and “UnitError” may appear inside the open frames. They disappear as soon as the file chooser box is closed again.

§ Missing default parameter: If a new data file is loaded with missing data for the default parameter (generally temperature), a correct error message appears, but an inactive split frame is constructed. This causes an error message (NullPointerException) when other files are tried to be opened afterwards.

§ Case error: If two open split frames exist, one related to a *.pro and the other to a *.met-file (see Section 4.4.1), and if the *.pro-file is active and a *.met-parameter is clicked (and vice versa), sometimes a new file is read instead of using the data already residing in memory. The already open split frame might not be recognized as usable, since some problems in the file name recognition may exist (upper/lower case error).

§ Slider missing: If new data files are loaded while the synchronization mode is active, the new split frames do not contain a movable slider.

5. Errors/shortcomings specific to SN_GUI installations under Unix:

§ Size of buttons (e.g. <OK>, < Cancel>) sometimes too small

§ Titles of split frames only appear if mouse is moved over them

§ File chooser box: In contrast to Windows installations, the most recently used working directory is not remembered by the operation system.

§ Mouse movements may cause error messages in the background console window (these should not be paid attention to)

§ Tool tip text missing: No explanation text appears when the mouse cursor is positioned over a button

6. Status bar:

Most of the messages to be displayed at the bottom of the visualization frame are not drawn in a reliable way.

7. Time resolution:

Sawtooth-like graphs can emerge in the left-hand part of split frames (for *.pro-files only), if the time difference between any two adjacent data records of the file is not constant.

8. Screen resolution

The SN_GUI was developed on a PC with a screen resolution of 1024 x 768 pixel and just sporadically tested for other resolutions. Using screens set to a lower resolution than this might cause parts of the included windows and user interfaces to be inaccessible.